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(54) Title: COMPUTERIZED SYSTEM AND ASSOCIATED METHOD FOR OPTIMALLY CONTROLLING STORAGE AND TRANSFER OF COMPUTER PROGRAMS ON A COMPUTER NETWORK		
(57) Abstract A computerized system and an associated method for optimally controlling storage and transfer of computer programs between computers on a network to facilitate interactive program usage. In accordance with the method, an applications program is stored in a nonvolatile memory of a first computer as a plurality of individual and independent machine-executable code modules. In response to a request from a second computer transmitted over a network link, the first computer retrieves a selected one of the machine-executable code modules and only that selected code module from the memory and transmits the selected code module over the network link to the second computer.		

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**COMPUTERIZED SYSTEM AND ASSOCIATED METHOD
FOR OPTIMALLY CONTROLLING STORAGE AND TRANSFER
OF COMPUTER PROGRAMS ON A COMPUTER NETWORK**

Background of the Invention

5 This invention relates to computing and communications on a computer network. More specifically, this invention relates to a computerized system and an associated method for optimally controlling storage and transfer of computer programs between computers on a network to facilitate interactive program usage.

 In the past several years, there has been an ever increasing number of individuals,
10 corporations and other legal entities which have obtained access to the global network of computers known as the Internet. More precisely described, the Internet is a network of regional computer networks scattered throughout the world. On any given day, the Internet connects roughly 20² million users in over 50 countries. That number will continue to increase annually for the foreseeable future.

15 The Internet has provided a means for enabling individual access to enormous amounts of information in several forms including text, video, graphics and sound. This multi-media agglomeration or abstract space of information is generally referred to as the "World-Wide Web," which is technically a "wide-area hypermedia information retrieval initiative aiming to give universal access to a large universe of documents." To obtain access to the World-Wide
20 Web, a computer operator uses software called a browser. The most popular browsers in the United States are Netscape Navigator and Microsoft's Internet Explorer.

 The operation of the Web relies on so-called hypertext for enabling user interaction. Hypertext is basically the same as regular text in that it may be stored, read, searched, and edited, with one important exception: a hypertext document contains links to other documents.
25 For instance, selecting the word "hypertext" in a first document could call up secondary

documents to the user's computer screen, including, for example, a dictionary definition of "hypertext" or a history of hypertext. These secondary documents would in turn include connections to other documents so that continually selecting terms in one documents after another would lead the user in a free-associative tour of information. In this way, hypertext
5 links or "hyperlinks" can create a complex virtual web of connections.

Hypermedia include hypertext documents which contain links not only to other pieces of text, but also to other media such as sounds, images and video. Images themselves can be selected to link to sound or documents.

The standard language the Web uses to create and recognize hypermedia documents is
10 the HyperText Markup ("HTML") Language. This language is loosely related to, but technically not a subset of, the Standard Generalized Markup Language ("SGML"), a document formatting language used widely in some computing circles. Web documents are typically written in HTML and are nothing more than standard text files with formatting codes that contain information about layout (text styles, document titles, paragraphs, lists) and
15 hyperlinks.

HTML is limited to display functions (text, animation, graphics, and audio) and form submission. Inherent in the basic HTML protocol (set of software-encoded rules governing the format of messages that are exchanged between computers) are design limitations that prevent the implementation of the type of program functionality that is commonly used in
20 today's desktop computers. Because of this limitation, it is impossible to enhance HTML documents with the features necessary to support the Internet applications currently being sought by industry and consumers.

Sun Microsystems and Netscape Communications have attempted to introduce additional program functionality through the implementation of Sun's Java programming

language as a browser plug-in. Microsoft, in addition to supporting Java, has introduced Active-X as a browser plug-in. Currently, after two years of development, both Java and Active-X are still failing to deliver working software. These languages are plagued by software errors that crash the newer operating systems. Even the developers of these

5 languages, Sun and Microsoft, are having major problems with Java and Active-X applications that they have written to demonstrate the capabilities of the languages.

Java, Active-X and almost all other programming languages use a programming paradigm based on the "C" programming language introduced by AT&T in the 1970's to develop the UNIX operating system. Although well suited for operating system development,

10 "C" has two major drawbacks for Internet content delivery. The first drawback is that an entire program must be loaded before anything can be executed using the program. Because Internet content is open-ended, most applications can become very large, making downloading impractical due to the limited bandwidth of most Internet connections. Typical Java and Active-X applications take several minutes to download before they start running. The second

15 drawback using programs based in "C" is that content development is very inefficient. "C" and programming languages based on the "C" paradigm are currently used to produce software tools and utilities such as word processors, spreadsheets, and operating systems. Software developers can assign a large number of programmers to a long-term project, with the knowledge that repeated sales of the product to existing users will recover the large investment

20 expenditure. However, developers of Internet content cannot afford this type of approach and have fallen back upon the very simple HTML protocol to economize development.

However, even HTML is inadequate to enable or facilitate the conducting of interactive programming on the Internet. Although well adapted to passively providing multimedia information, HTML is extremely limited in active and interactive software use and

development. Thus, companies seeking to conduct commercial activities on the Internet are seeking a programming tool or information-exchange methodology to replace HTML or to provide major enhancement to that language. In contrast to applications programs based on the "C" paradigm, Internet applications programming is generally not subject to multiple uses.

- 5 Rather an Internet program is consumed: the program is used only once by the typical user. Utilities-type software developed for individual computer use, such as word processors, spread sheets, E-mail, etc., can be sold at higher prices because the software is used again and again by any individual.

Programming languages based on the "C" programming paradigm are awkward for
10 programming interactions involving the computer's display screen. For example, a Microsoft program for the manipulation of sprites (graphic images that can move over a background and other graphic objects in a nondestructive manner) requires over 800 lines of "C" code and over 290 lines of assembler code. The same program written in the TenCORE language requires only six lines.

- 15 TenCORE is a modular programming language designed in the early 1980's to facilitate the transfer of information between disk drives and RAM, particularly for the delivery of interactive instruction ("Computer-Based Training"). At that time, disk drives were all slow and RAM was inevitably small. In adapting to these hardware limitations, TenCORE introduced the use of small individual code modules for performing respective functions,
20 thereby enabling efficient performance as each code module loaded a single interaction from the slow disk drives. Programming in the form of substantially independent code modules is open-ended, a necessary characteristic for educational software requiring the delivery of whatever remedial instruction is required by the individual student. TenCORE utilizes a program called an "interpreter" that implements all basic required functions efficiently. The

interpreter has no content itself. The content comes from an unlimited number of small pseudocode modules which are loaded into the system memory and issue commands to the interpreter. In writing a program, the programmer's involvement is reduced to simply issuing commands, leaving all the difficulties of implementation to the interpreter.

5 In contrast to TenCORE, "C" type programming includes a series of pre-written code libraries which are linked together as they are compiled. In theory, when a new microprocessor is designed, only the code libraries need to be rewritten and then all programs can be re-compiled using the new libraries. However, over the past twenty years the number of these code libraries has grown to a point where the original concept of rewriting for
10 different microprocessors is no longer practical because of the difficulty in compensating for subtle differences between microprocessors. What remains is a complex and difficult programming syntax that takes years to master and is very difficult to debug.

Objects of the Invention

A general object of the present invention is to provide a method for communicating
15 over a computer network.

A more particular object of the present invention is provide a method for enabling or facilitating the conducting of interactive programming over a computer network such as the Internet.

A related object of the present invention is to provide a method for communicating
20 software over a computer network, to enable an increased degree of interactive computer use via the network.

Another object of the present invention is to provide a computing system for enabling or facilitating the conducting of interactive programming over a computer network such as the Internet.

It is a further object of the present invention to provide a computing system for communicating software over a computer network, to enable an increased degree of interactive computer use via the network.

These and other objects of the present invention will be apparent from the drawings and descriptions herein.

Summary of the Invention

The present invention is directed to a computerized system and to an associated method for optimally controlling storage and transfer of computer programs between computers on a network to facilitate interactive program usage. In accordance with the method, an applications program is stored in a nonvolatile memory of a first computer as a plurality of individual and independent machine-executable code modules. In response to a request from a second computer transmitted over a network link, the first computer retrieves a selected one of the machine-executable code modules and only that selected code module from the memory and transmits the selected code module over the network link to the second computer.

In one important field of use of the invention, the first computer is a server computer on a network. The second computer may be a user computer or a secondary server. Alternatively, the two computers may be two individual user computers on the network.

Where the second computer is a user computer, the request for the executable code module arises because the user needs the code module to perform a desired function in the applications program. The user's computer does not have all of the code modules of the applications program and obtains new code modules only as those modules are needed. Because executable code of the applications program is broken down into individually executable modules, the program can be downloaded piecemeal, module by module, as the

individual modules are needed by the user's execution of the program. Accordingly, the user need not wait for the entire program to be downloaded before the user can start using the program.

Where the first computer and the second computer are a primary server and a
5 secondary server, respectively, the present invention allows the primary server, when is too busy to handle a user request or task, to hand that request or task off to the secondary server. When a primary server receives a user request or task that the server cannot handle due to load, that request or task is forwarded preferably to the least busy secondary server available. The secondary server then processes the user request and responds to the client/user directly.
10 If the secondary server does not have a code module, data file, or other resource required to handle the user request, the required code module, data file, or other resource can be transferred to the secondary server from the first server. This shunting of user requests contemplates the utilization of multiple secondary servers located on different Internet connections. The present invention thus eliminates most bandwidth and server load issues on
15 the Internet and other computer networks.

Of course, a server computer must shed its load before the server reaches its full capacity, thereby leaving enough system resources (processor, memory, etc.) free to fulfill any requests from a secondary server for resources necessary for the secondary server to fulfill a shunted user request or task.

20 If a secondary server is unable to contact the client machine, the secondary server can forward the user request to another secondary server for processing, since the other secondary server may be able to reach the client machine directly.

A secondary server may also serve as a backup server. In that case, the secondary server immediately requests all code modules, data files, and other resources from the primary

server instead of waiting for a client request that requires one of those resources. When a client or secondary server makes a request of the primary server and discovers it to be inaccessible, the request can then be made of a backup server. In this way, if a primary server were to fail, the information that was on the primary server would still be accessible through the backup server. To facilitate the maintenance of up-to-date resources on backup servers, the primary server sends notification packets to each of the backup servers whenever a resource is created or updated. The backup servers can then request the new, updated copy of the resource from the primary server, thereby remaining up to date with the primary server at all times.

In order to optimize processing of user requests, a primary server stores in its memory a list of secondary servers on the network, the list including response times and load statistics (processor usage, etc.) for the respective secondary servers. The primary server periodically updates these response times, by sending echo packets to the secondary servers and measuring delays between the sending of the echo packets and a receiving of responses to the echo packets from the respective secondary servers. The server also periodically updates the load statistics by requesting the current load statistics from the secondary servers. For processing a recently received user request, the primary server scans the list in memory and selects the secondary server having the lightest load and shortest response time.

For security purposes, code modules, as well as other resources such as data files, are transmitted in encrypted form. Encryption is accomplished by placing the code modules, files, documents or other transmittable resources in the data area of an encryption packet. When an encrypted packet is received, it is decrypted and the code modules, files, documents or other transmittable resources subsequently handled pursuant to normal procedures. The encryption/decryption process can be handled by a plug-in code module. Any number of plug-

in encryption code modules may exist in a data and code transfer system in accordance with the invention at any one time. The header of an encryption packet contains an indication of which plug-in encryption code module must be used for decryption purposes.

Encryption/decryption code modules can be delivered real time by a code module exchange
5 protocol.

To further enhance the security of the system, the primary server stores a list of user authentication codes in its memory. Upon receiving a request, e.g., for a machine executable code module, from another computer, the primary server compares a user authentication code in the request with the stored list of user authentication codes. The primary server proceeds
10 with retrieving and transmitting a selected machine-executable code module only if the user authentication code in the request matches a user authentication code in the stored list.

Where an incoming request for a machine-executable code module is contained in an encryption packet, the server decrypts the encryption packet prior to the comparing of the user authentication code in the request with the list of user authentication codes in the memory.

15 Encrypting and decrypting of encryption packets, as well as the checking of user authentication codes, may be performed by the secondary server(s). Whatever programming or data required for carrying out these security measures can be transmitted from the primary server in accordance with the present invention.

The present invention provides for the updating of an applications program in users'
20 machines. When a user sends a request for a code module to a server, the request includes a specification of the version of the program code sought. The server processing the request checks whether the requested version is the latest version available. When a newer version of a requested code module is available, the server informs the user and inquires whether the user could use the newer version of the requested module. The user could then send a request for

the updated version of the desired code module.

If the updated version of the desired code module is incompatible with older versions of other code modules, the older version of the desired code module will be transmitted from the server to the user. If the older version is not available, the user may have to request

5 transmission of the newer versions of several additional modules.

Generally, it is contemplated that machine-executable code modules are written in a user-friendly programming code such as TenCORE. In that case, a software-implemented interpreter unit of the user computer translates the code modules from the programming code into machine code directly utilizable by the user computer. When such an interpreter is used,

10 the interpreter itself can be updated in the same fashion as an application program or code module. For purposes of updating the interpreter, the interpreter is treated as a single large code module.

In a related method in accordance with the present invention for optimally controlling storage and transfer of computer programs between computers on a network to facilitate

15 interactive program usage, a portion of an applications program is stored in a first computer. The applications program comprises a plurality of individual and independent machine-executable code modules. Only some of the machine-executable code modules are stored in the first computer. This method includes executing at least one of the machine-executable code modules on the first computer, transmitting, to a second computer via a network link, a

20 request for a further machine-executable code module of the applications program, receiving the further machine-executable code module at the first computer from the second computer over the network link, and executing the further machine-executable code module on the first computer.

To further facilitate program transfer on the network, the first computer may conduct

an investigation into server availability. Pursuant to this feature of the invention, a request is sent from the first computer (e.g., a user) to a further computer (e.g., a primary server) for a list of servers (e.g., secondaries) on said network. After transmission of the list of server to the first computer, response times for the server are determined by (a) sending echo packets
5 from the first computer to the servas, (b) measuring, at the first computer, delays between the sending and receiving of the echopackets, (c) querying the servers as to current server load (processor usage, etc.) The request for a further machine-executable code module is sent to the server having the lightest load and shortest measured response time. The list of servers can be cached in memory by the first computer to facilitate further access to the information in the
10 event that the server from which the list was requested becomes unavailable or is too busy to handle the request.

In the event that there has been an update in a requested code module, a request from the first computer for a particular version of the code module may trigger an inquiry as to whether the first computer could use the updated version of the code module. If so, the first
15 computer transmits a second requests, this time for the updated version of the desired code module.

Where the two computers are both user machines, the method of the present invention facilitates interactive processing. Each computer executes one or more selected code modules in response to the execution of code modules by the other computer. Thus, both computers
20 store at least some of the machine-executable code modules of the applications program. Occasionally one computer will require a code module which it does not have in present memory. Then the one computer can obtain the required code module from the other computer. If the other computer does not have the required module, a request may be made to a server on which the applications program exists in its entirety.

Where the machine-executable code modules are written in a user-friendly programming code, each user computer includes an interpreter module implemented as software-modified generic digital processing circuits which translates the code modules from the programming code into machine code utilizable by the respective computer.

5 In accordance with a feature of the present invention, the machine-executable code modules each incorporate an author identification. The method then further comprises determining, in response to an instruction received by a user computer over the network and prior to executing the one of the machine-executable code modules on the user computer, whether the particular author identification incorporated in the one of the machine-executable
10 code modules is an allowed identification. The user computer proceeds with code module execution only if the particular author identification is an allowable identification. Generally, the instruction determining whether a code module is written by an allowed author is a list of blacklisted authors.

The author identification feature of the invention serves to prevent an author from
15 creating a virus or other malicious program and distributing it using the code module exchange protocols of the present invention. All compilers supporting the coding of individual machine-executable code modules in accordance with the present invention will incorporate a respective author identification code into each machine-executable code module. The author identification is unique to each author. When a malicious program is discovered, the
20 identification of the author may be distributed throughout the network to blacklist that author and prevent the execution of code modules containing the blacklisted author's identification. As an additional advantage, this feature will discourage users from distributing illegal copies of the authoring package, since the respective users will be held responsible for any malicious programs written under their author identification.

The storing of applications program modules in a user computer may include caching the code modules in a nonvolatile memory of the user computer.

It is to be noted that the present invention permits the transmission during user computer idle time of code modules whose use is anticipated. A request from the user
5 computer is transmitted to a server or other computer for a machine-executable code module during an idle time on the user computer.

A computing system comprises, in accordance with the present invention, digital processing circuitry and a nonvolatile memory storing general operations programming and an applications program. The applications program includes a plurality of individual and
10 independent machine-executable code modules. The memory is connected to the processing circuitry to enable access to the memory by the processing circuitry. A communications link is provided for communicating data and programs over a network to a remote computer. A code module exchange means is operatively connected to the memory and to the communications link for retrieving a single code module from among the machine-executable code modules and
15 transferring the single code module to the remote computer in response to a request for the single code module from the remote computer.

As discussed above, the computing system of the present invention may be a server computer on the network. The server's memory may contain a list of secondary servers on the network, the list including response times for the respective secondary servers. The computing
20 system then further comprises a detection circuit, generally implemented as software-modified generic digital processing circuitry, for detecting an overload condition of the computing system. A server selector, also generally implemented as software-modified generic digital processing circuitry, is operatively connected to the detection circuit, the memory and the communications link for determining which of the secondary servers has a shortest response

time and for shunting an incoming user request to the secondary server with the shortest response time when the overload condition exists at a time of arrival of the user request.

Thus, the remote computer transmitting a code-module request to the computing system may be a secondary server to which a user request has been shunted. The requested
5 single code module is required for enabling the remote computer to process the user request. On behalf of the computing system.

Pursuant to another feature of the present invention, the computing system further comprises an updating unit, preferably implemented as software-modified generic digital processing circuitry, operatively connected to the memory and the communications link for (1)
10 periodically sending echo packets to the secondary servers, (2) measuring delays between the sending of the echo packets and a receiving of responses to the echo packets from the respective secondary servers, and (3) updating the response times in the list in accordance with the measured delays.

For security purposes, the memory of the computing system may contain a stored list
15 of user authentication codes. The computing system then includes a comparison unit, preferably implemented as software-modified generic digital processing circuitry, for comparing a user authentication code in an incoming request with the list of user authentication codes in the memory and for preventing code-module retrieval and transmission in the event that the user authentication code in the request fails to correspond
20 to any user authentication code in the list.

Where incoming requests for code modules are contained in encryption packets, the computing system further comprises a software-implemented decryption circuit connected to the communications link and the comparison unit for decrypting the encryption packet prior to the comparing of the user authentication code in the request with the list of user

authentication codes in the memory.

In accordance with another feature of the invention, the computing system includes means for determining whether a requested code module has an updated version and for responding to the request with an invitation to the remote computer to accept the updated
5 version of the requested code module.

It is contemplated that the machine-executable code modules are written in a user-friendly programming code. Where the computing system uses the applications code itself, the computing system further comprises an interpreter for translating the programming code into machine code directly utilizable by the processing circuitry. The interpreter may take the form
10 of generic digital processing circuit modified by programming to perform the translation function.

A computing system (e.g., a user computer on a network) also in accordance with the present invention comprises a memory storing a portion of an applications program having a plurality of individual and independent machine-executable code modules, only some of the
15 machine-executable code modules being stored in the memory. A digital processing circuit is operatively connected to the memory for executing at least one of the machine-executable code modules. A communications link is provided for communicating data and programs over a network to a remote computer. A code module exchange unit is operatively connected to the memory and to the communications link for communicating with a remote computer (e.g., a
20 server on the network) via a network link to obtain from the remote computer a further machine-executable code module of the applications program. The digital processing circuitry is operatively tied to the code module exchange unit for executing the further machine-executable code module upon reception thereof from the remote computer.

When a client or user machine is not running at full capacity (processor idle time is over

a given threshold and network traffic is under a given threshold), that machine can look for other client machines on the same virtual network that may be in the midst of a processor-intensive task and take on some of the load. If necessary, the code modules to handle that task can be transferred to the idle client machine. It is possible for clients working together on the same project to communicate with each other using a custom sub-protocol. This client-side distributed processing significantly improves the performance of processor-intensive tasks.

The present invention provides a programming paradigm which addresses the Internet content developer's specific needs. A software system and computer communications method in accordance with the present invention delivers rapidly over the Internet, provides a practical programming paradigm that supports rapid economical development of content, and facilitates new capabilities in Internet software and systems management.

TenCORE, a modular programming language designed to use small efficient code modules for facilitating program transfer between disk drives and central processing units of desktop computers, may be easily modified to carry out the present invention. Minimal modifications require the adapting of the transfer capabilities to work over network links.

The present invention arises in part from the realization by the inventors that the problems facing the developers of TenCORE in 1980 are the same problems that software designers face today when dealing with the Internet and its limited bandwidth and slow connections. It was perceived that Internet applications must be open-ended and programming must be delivered rapidly in spite of bandwidth limitations. Thus, the solution provided by TenCORE is useful in solving today's problems with interactive software on the Internet. The modular programming of TenCORE enables rapid Internet performance because a single TenCORE Net programming module can be quickly downloaded over the Internet. The TenCORE Net programming modules are TenCORE programming modules which are

modified to enable downloading from Internet servers instead of from a microcomputer's disk drive.

TenCORE and TenCORE Net are interpreted languages, i.e., they serve to translate into machine language pseudocode programs and to perform the indicated operations as they
5 are translated. "Pseudocode" is unrelated to the hardware of a particular computer and requires conversion to the code used by the computer before the program can be used. Once the TenCORE Net interpreter is installed on a computer equipped with an Internet connection, clicking with a mouse on a conventional World-Wide Web hyperlink that points to a TenCORE Net application automatically bypasses the Internet browsing software and launches
10 the application. Because only the required modules are sent over the Internet and because the TenCORE Net modules are very small, Internet performance is very fast.

Brief Description of the Drawing

Fig. 1 is a block diagram of a computer network with various servers and user computers, which transmit executable programs to one another pursuant to the present
15 invention.

Fig. 2 is a block diagram of a primary server in accordance with the present invention.

Fig. 3 is a block diagram of a user computer in accordance with the present invention.

Fig. 4 is a flow chart diagram illustrating a maintenance loop in the operation of selected program-modified processing circuits in the primary server of Fig. 2 and the user
20 computer of Fig. 3.

Fig. 5 is a flow chart diagram illustrating a loop for processing an incoming data packet in the operation of selected program-modified processing circuits in the primary server of Fig. 2 and the user computer of Fig. 3.

Figs. 6A and 6B are a flow chart diagram illustrating further operations relating to the

processing of an incoming request for a code module in accordance with the present invention.

Fig. 7 is a flow chart diagram illustrating a subroutine for processing an incoming resource request packet in the operation of selected program-modified processing circuits in the primary server of Fig. 2 .

5 Fig. 8 is a flow chart diagram illustrating a maintenance loop in the operation of selected program-modified processing circuits in the primary server or a secondary server of Fig. 2.

10 Fig. 9 is a flow chart diagram illustrating a subroutine for processing an incoming resource request packet in the operation of selected program-modified processing circuits in the primary server of Fig. 2 .

Fig. 10 is a flow chart diagram illustrating a maintenance loop in the operation of selected program-modified processing circuits in the primary server or a secondary server of Fig. 2.

Description of the Preferred Embodiments

15 As illustrated in Fig. 1, a computer network comprises a plurality of user computers 12 operatively connected to a primary server computer 14 via a complex of network links 16. The primary server 14 stores, in an area 18 of a nonvolatile memory 20 (Fig. 2), an applications program which may be desired for use on one or more user computers 12. The term "applications program" as used herein refers to any executable collection of computer
20 code other than operating systems and other underlying programming for controlling basic machine functions.

As further illustrated in Fig. 1, the network includes a plurality of secondary servers 22 which are available for assisting primary server 14 in responding to requests from user computers 12. More particularly, as shown in Fig. 2, primary computer 14 includes an

overload detector 24 which continually monitors a queue of jobs or tasks which primary server 14 has to perform. Overload detector 24 determines whether the number and size of tasks in the queue has exceeded a predefined threshold. Once that threshold is reached, overload detector 24 signals a secondary server selector 26 which accesses an area 28 of memory 20 to
5 identify a secondary server 22 which is least busy. To that end, memory area 28 contains a list of secondary servers 22 as well as measured response times for the respective servers.

The response times in the secondary-server list in memory area 28 are periodically measured by dispatching echo packets to each secondary server 22 and measuring the delays between the transmission of the respective echo packets from primary server 14 and the receipt
10 of responses from the respective secondary servers 22. To accomplish the measurement, primary server 14 and, more particularly, a processing unit 30 thereof contain an echo packet dispatcher 32 and a response-time monitor 34. Upon transmitting an echo packet to a secondary server 22 via a network communications interface 36 at primary server 14, dispatcher 32 notifies response-time monitor 34 as to the transmission of a packet and as to the
15 secondary server 22 to which the transmission was made. Monitor 34 counts out the time between the transmission of the echo packet and the arrival of a response from the respective secondary server 22 via network links 16 and communications interface 36. A response-time update unit 38 is connected to response-time monitor 34 and to memory area 28 for writing updated response times in the secondary server list stored in memory area 28.

20 The applications programs store 18 in memory 20 contains a multiplicity of individual and independent machine-executable code modules. Accordingly, a user computer 12 working with the applications program need not be loaded with the entire program in order to begin processing operations. In the event that the user's execution of the applications program requires a code module not contained in the user's computer memory, a request is transmitted

from the user computer 23 over network links 16 to primary server 14. If primary server 14 is not overloaded, it retrieves the requested code module from program store 18 and transmits it over communications interface 36 and network links 16 to the user computer which made the request.

5 Processing unit 30 of primary server 14 includes a code-module exchanger 40 which processes incoming requests for code modules of the applications program or programs stored in memory area 18. Exchanger 40 cooperates with a version detector 42 which consults the applications program store 18 to determine whether a requested version of a particular code module is the latest version in store 18. If not, version detector 42 and code module exchanger
10 40 transmit an inquiry to the resting computer as to whether the latest version of the desired code module is utilizable by the requester. If the newer version of the desired code module can be used in place of the older version, the newer version is transmitted over communications interface 36 and network links 16.

Code modules, as well as other resources such as data files, may be transmitted in
15 encrypted form for security purposes. Encryption is accomplished by placing the code modules, files, documents or other transmittable resources in the data area of an encryption packet. When an encrypted packet is received by processing unit 30 via communications interface 36, the packet is forwarded via generic processing circuits 50 to an encryption/decryption unit 44 for deciphering. Encryption/decryption unit 44 consults a
20 memory area 46 containing a plurality of possible encryption keys and selects an encryption key identified by header information in the encryption packet containing the user request. Upon decryption of the incoming encryption packet, the user request or code module exchange packet contained therein is forwarded to code-module exchanger 40 for processing. The encryption/decryption process can be handled by a plug-in code module performing the

functions of encryption/decryption unit 44 and memory area 46. Any number of plug-in encryption code modules may exist in a data and code transfer system at any one time. The header of an encryption packet contains an indication of which plug-in encryption code module must be used for decryption purposes.

5 To further enhance the security of a computer network which has protocols for the exchange of executable code modules, primary server 14 stores a list of user authentication codes in a memory area 48. In response to a request, e.g., for a machine-executable code module, from another computer, comparator 52 in processing unit 30 compares a user authentication code in the request with the list of user authentication codes stored in
10 memory area 48. Code module exchanger 40 proceeds with retrieving and transmitting a selected machine-executable code module only if the user authentication code in the request matches a user authentication code in the stored list. Where an incoming request for a machine-executable code module is contained in an encryption packet, encryption/decryption unit 44 deciphers the encryption packet prior to the comparing by comparator 52 of the user
15 authentication code in the request with the list of user authentication codes in memory area 48. Where a user request is relayed to a secondary server 22 chosen by selector 26, the secondary server incorporates an encryption/decryption unit and an authentication-code comparator for encrypting and decrypting of encryption packets and the checking of user authentication codes, may be performed by the secondary server(s). Whatever programming
20 or data required for carrying out these security measures can be transmitted from primary server 14 to the selected secondary server 22.

As illustrated in Fig. 3, a processing unit 54 of a user computer 12 includes a code-module exchanger 56 which generates requests for desired code modules of an applications program as those code modules are required during execution of the applications program by

the user. The code-module requests are transmitted to code-module exchanger 40 of primary server 14 via a network communications interface 58 at user computer 12, network links 16 (Fig. 1) and communications interface 36 at primary server 14.

In a security enhanced system, processing unit 54 of user computer 12 includes a
5 encryption/decryption unit 60 which inserts code-module request packets, as well as other information transfer packets, into the data areas of respective encryption packets whose encryption keys are selected from a plurality of keys stored in an area 62 of a nonvolatile memory 64 of user computer 12. Again, the encryption/decryption process at user computer 12 can be handled by a plug-in code module performing the functions of encryption/decryption
10 unit 60 and memory area 62. The header of an encryption packet generated by encryption-decryption unit 60 contains an indication of which plug-in encryption code module at primary server 14 must be used for decryption purposes.

In a further security enhancement used to protect the computing system of Fig. 1 in general and user computer 12 in particular from computer viruses and other malicious
15 programming, processing unit 54 is provided with an author identification comparator 66 which accesses an author identification list 68 in memory 64. Author identification list 68 is periodically updated by author identification comparator 66 and other function-converted blocks in generic processing circuits 70 in response to incoming instructions from primary server 14. Author identification list 68 contains a list of allowed authors or, perhaps more
20 efficiently, a list of authors who have been blacklisted owing to their passing of viruses or other malicious programming onto the network. Prior to the use of an incoming machine-executable code module. The author identification in a packet header is checked by comparator 66 to determine that the author of the particular code module has not been blacklisted. If the author is allowed to produce executable code modules for user computers 12, processing of the

incoming code module proceeds normally. If, on the other hand, the author of the incoming code module has been blacklisted, then the code module is never executed and may be discarded prior to storage in an applications program store 72 in memory 64.

As discussed above with reference to Figs. 1 and 2, primary server 14 may occasionally
5 hand off an incoming user request to a secondary server 22, depending on the load condition of the primary server and the secondary servers. Generally, this handing off of responsibility for responding to users' requests is transparent to the users, i.e., the processing of users' requests proceeds without knowledge or intervention by the users. It is also possible for user computers 12 to take over selection of a secondary computer 22 from primary computer 14.
10 To that end, processing unit 54 of user computer 12 is provided with a secondary server selector 74 which accesses a list 76 of secondary-servers in memory 64. Generally, selector 74 selects a secondary server 22 with a smallest response time relative to the respective user computer 12. To that end, processing unit 54 further includes an echo packet dispatcher 78, a response-time monitor 80 and a response-time update unit 82. Dispatcher 78 sends echo
15 packets to secondary servers 22 via communications interface 58 and network links 16 (Fig. 1), while monitor 80 determines the delays of responses from the various secondary servers. Update unit 82 corrects response time data in list 76 in accordance with measurements carried out by dispatcher 78 and monitor 80. It is contemplated that the updating of secondary-server response times in list 76 is implemented only when user computer 12 requires a user module or
20 other resource from primary server 14 and that server is too busy to handle the user request.

Processing unit 54 of a user computer 12 has a distributed processing circuit 84 which enables processing unit 54 to share the processing of large tasks with other user computers in the network. Thus, when a user computer is not running at full capacity (processing unit 54 is more than 50% idle and there is no network traffic), that distributed processing circuit 84

looks for other user computers 12 that may be in the midst of a processor-intensive task and enable transfer of some of the load to the processing unit 54 of the respective user computer 12. If necessary, the code modules to handle that task can be transferred to the idle user computer 12. This client-side distributed processing significantly improves the performance of
5 processor-intensive tasks.

Processing unit 54 of a user computer 12 also contains a metered delivery and billing circuit 86 which controls access to content which must be paid for. Credit registers 88 in memory 64, accessible by circuit 86, store credits which the particular user has against respective accounts. When credit in an account maintained or monitored by primary server 14
10 is low, circuit 86 may arrange for the transfer of more credit from primary server 14 to the particular user. Metered delivery and billing circuit 86 includes a billing method to pay for the credit. Generally, credit requests and responses thereto should be encrypted.

Processing unit 54 of a user computer 12 additionally includes a unidirectional data submission and collection circuit 90 which accesses data files 92 in memory 64 for purposes of
15 uploading those data files to primary server 14 or to a selected secondary server 22. Data submission and collection circuit 90 is operative when the user computer does not need to read the data back from the server. This circuit is particularly useful for on-line orders, form submission, and data collection (including statistical data) among other things.

Generally, packets that contain data to be written must be sent directly to the primary
20 server 14 and cannot be shunted. This prevents conflicts between different versions of the resource that was written to. Data written back to the server should require user authentication. User authentication should be used even if the write-back will be done only by a program under author control. In that case, user identification codes and passwords can be built into the program. The reason for this is to prevent another author from writing a

program that would write back to the same data and possibly corrupt it.

Applications program code modules stored in memory area 18 (Fig. 2) and module store 72 (Fig. 3) are written in TenCORE, a modular programming language originally designed to use small efficient code modules for facilitating program transfer between disk drives and central processing units of desktop computers. TenCORE is easily modified, for example, to adapt the code transfer capabilities to operate over network links. The program so modified for use on user computers 12, primary server 14 and secondary servers 22 may be called "TenCORE Net."

TenCORE Net uses small individual code modules for performing respective functions, thereby enabling efficient performance as each code module is downloaded a single interaction from primary server 14 or a selected secondary server 22. Programming in TenCORE Net is open-ended, so that a user computer 12 executes instructions of an applications program when that applications program is only partially stored in program store 72 of memory 64.

The code modules held in memory store 72 are in a user-friendly pseudocode language which must be translated or interpreted for direct machine use. To that end, processing unit 54 includes a program or programmed interpreter circuit 94 that implements all basic required functions efficiently. The interpreter has no content itself. Content is derived from a potentially unlimited number of small pseudocode modules which are loaded into memory store 72 and which effectively issue commands to interpreter 94. In writing a program, the programmer's or author's involvement is reduced to simply issuing commands, leaving all the difficulties of implementation to the interpreter.

TenCORE may be modified in two ways to enable network use. First, a subroutine or set of instructions may be inserted before each call line of computer code for checking whether the code intended for execution exists in applications program memory area 72. If not, code

module exchanger 56 is instructed to obtain the required code module from primary server 14. Once the required code module has been downloaded into memory area 72, it is called and translated by interpreter circuit 94 prior to execution by processing circuits 70.

Through the use of modular applications programs and code-module exchangers 40 and 56, the control of computer program storage and transfer between computers 12, 14, 22 on a network is optimized, thereby facilitating interactive program usage. An applications program stored in nonvolatile memory area 18 of primary server 14 may be transferred to various user computers 12 in modular fashion. In response to a request transmitted over network links 16 from a user computer 12 or a selected secondary server 22, primary server 14 retrieves a selected machine-executable code module and only that selected code module from memory area 18 and transmits the selected code module over network links 16 to the user computer or secondary server.

Where the applications program is, for instance, a drawing or painting program, a user computer 12 may be instructed to draw a three-dimensional geometric figure such as a truncated pyramid. If processing circuits 70 discover that the applications program in program store 72 is missing a code module required for performing that task, code module exchanger 56 requests that the requisite module be transferred from primary server 14. In response to that request, version detector 42 may find that a later version of the desired module exists and inquire of code-module exchanger 56 whether the later version would be acceptable for use by the respective user computer.

Thus, user computers 12 do not have all of the code modules of the applications program and obtain new code modules only as those modules are needed. Because executable code of the applications program is broken down into individually executable modules, the program can be downloaded piecemeal, module by module, as the individual modules are

needed by the user's execution of the program. Accordingly, the user need not wait for the entire program to be downloaded before the user can start using the program.

Similarly, a selected secondary server 22 can begin to process a transferred or shunted user request and respond to the client/user directly, without having the entire applications

5 program and other resources relating to the handling of the program's distribution by the primary server 14. If the selected secondary server does not have a code module, data file, or other resource required to handle the user request, the required code module, data file, or other resource can be transferred to the secondary server from the primary server. Secondary servers 22 are thus provided with code module exchangers similar to exchangers 40 and 56.

10 Of course, primary server 14 must shed its load before that server reaches its full capacity, thereby leaving enough system resources (processor, memory, etc.) free to fulfill any requests from a secondary server for resources necessary for the secondary server to fulfill a shunted user request or task.

In security sensitive networks, secondary servers 22 are equipped with
15 encryption/decryption units like unit 44, as well as authentication comparators 52. Where an incoming request for a machine-executable code module is contained in an encryption packet, the secondary server decrypts the encryption packet prior to the comparing of the user authentication code in the request with a list of user authentication codes in memory. Whatever programming or data required for carrying out these security measures can be
20 transmitted from primary server 14.

If a secondary server is unable to contact the client machine, the secondary server can forward the user request to another secondary server for processing, since the other secondary server may be able to reach the client machine directly.

Code module exchanger 56 of processing unit 54 facilitates interactive processing on a

network. Each user computer 12 executes one or more selected code modules in response to the execution of code modules by the other computer. Thus, both computers store at least some of the machine-executable code modules of the applications program. Occasionally, one computer will require a code module which it does not have in present memory. Then the one
5 computer can obtain the required code module from the other computer. If the other computer does not have the required module, a request may be made to a server on which the applications program exists in its entirety.

Thus, clients or users on a network are able to exchange code modules with one another. If a first user and a second user are engaged in an interactive whiteboarding session
10 and the first user starts drawing with a tool that the second user does not have in her version of the whiteboarding program, the code module or modules for that tool can be transferred automatically from the first user's computer to the second user's computer.

It is to be noted that code module exchanger 56 may be instructed to initiate the transmission during user computer idle time of code modules whose use is anticipated. A
15 request from the user computer 12 is transmitted to primary server 14 or other computer for a machine-executable code module during an idle time on the user computer. Resource requests that are generated for idle-time downloading should be flagged as such, so that code module exchanger 56 can assign different priorities from standard requests for load balancing and distribution purposes. The status of a resource request can be upgraded to real time from idle
20 time in the event that the user attempts to access the associated section of the application.

It is to be noted that the various dedicated function blocks of processing units 30 and 54 are generally and preferably implemented as software-modified generic digital processing circuits. Accordingly, code-module exchanger 40 and 56 are characterizable as protocols for the exchange of code modules between a server 14 or 22 and a user computer 12. This code

module exchange protocol is considered a subprotocol of a Modularized Code Master Protocol ("MCMP") which handles load distribution, user authentication and encryption. Load distribution is more particularly handled in primary server 14 by processor overload detector 24 and secondary-server selector 26, while user authentication and encryption are
5 handled in primary server and secondary servers 22 by comparator 52 and encryption/decryption unit 44.

The MCMP has four subprotocols, namely, the Code Module Exchange Protocol ("CMXP"), the Uni-Directional Data Submission and Collection Protocol ("UDSCP"), the Metered Delivery and Billing Protocol ("MDBP"), and the Distributed Processing Protocol
10 (DPP"). The Code Module Exchange Protocol is realized by code-module exchanger 40 in processing unit 30 of primary server 14 and secondary servers 22 and by code-module exchanger 56 in processing unit 54 of user computers 12. The Uni-Directional Data Submission and Collection Protocol is implemented by circuit 90 in user computers 12 and by corresponding non-illustrated program-modified processing circuitry in primary server 14.
15 The Metered Delivery and Billing Protocol finds realization by circuit 86 in user computers 12 and by corresponding non-illustrated program-modified processing circuitry in primary server 14. The Distributed Processing Protocol takes the form of circuit 84 in processing unit 54 of user computers 12.

Fig. 4 illustrates operations undertaken by echo dispatcher 32, response-time monitor
20 34, and update unit 38 as well as other processing circuits of processing unit 30 of primary server 14 to maintain an updated list 28 of the availability of secondary servers 22. The same steps may be performed by echo dispatcher 78, response-time monitor 80, and update unit 82 as well as other processing circuits of processing unit 54 of user computer 12 to obtain an updated list of secondary server response times. In an inquiry 100, echo dispatcher 32 or 78 or

generic processing circuits 50 or 70 query whether the time since the last echo testing is greater than a predetermined maximum period TMR. If the maximum period has been exceeded, echo packet dispatcher 32 or 78 transmits, in a step 102, an echo packet to the secondary server 22 which was tested the least recently. Response-time monitor 34 or 80
5 determines in an inquiry 104 whether a response has been received from the targeted secondary server 22. If a response has not been received and if a prespecified number of measurement attempts has not been exceeded, as determined at a decision junction 106, another echo packet is dispatched in step 102. If a response is received from the targeted secondary server 22, update unit 38 or 82 then records, in list 28 or 76, the time between the initial packet
10 transmission by dispatcher 32 or 78 and the receipt of the echo packet by monitor 34 or 80. This recordation is effected in a step 108. If the number of attempts at secondary-server response-time measurement has exceeded the pre-specified number, as determined at decision junction 106, the server is marked in list 28 or 76 as being unavailable (step 110). Also a message or alert signal may be generated to inform a server overseer. If at query 100, it is
15 determined that the time since the last echo testing is less than predetermined maximum period TMR, processing unit 30 or 54 investigates at 112 whether there is a packet in a MCMP incoming packet queue. If not, the maintenance loop of Fig. 4 is re-entered. If so, a packet processing operation 114 is executed. It should be noted that the MCMP incoming packet queue contains both packets received from the network, and packets placed into the queue by
20 the MCMP protocol.

Figs. 6A and 6B illustrate operation 114 carried out under the MCMP protocol by processing unit 30 of primary server 14 or of a secondary server 22 selected for overflow handing. In an initial inquiry 124, overload detector 24 decides whether processing unit 30 is too busy to handle the incoming packet (which may be, for example, a user request for a code

module). If so, processing circuits 50 investigate the MCMP packet header at a junction 126 to determine whether the packet can be shunted to a secondary server 22. If so, a further investigation 128 is conducted to determine whether the incoming packet has already been shunted. If the packet was sent to the server directly by the originating computer (i.e., not shunted), secondary-server selector 26 accesses list 28 in a step 130 to find the secondary server 22 with the lightest load. At a subsequent inquiry 132, processing unit 30, and more particularly, server selector 26, determines whether the selected secondary server is suitable for transfer of responsibility for the incoming packet. If the selected secondary server is suitable, the packet is flagged as the result of a service hand-off and forwarded to the selected secondary server (step 134).

If the secondary server selected in step 130 is not suitable for a hand-off, for example, if the response time of the secondary server is greater than a predetermined maximum, as determined at inquiry 132, a query 136 is made as to whether an incoming packet is the result of a service hand-off. This inquiry 136 is also made if the packet cannot be shunted, as determined at decision junction 126.

If an incoming MCMP packet is the result of a service hand-off, as determined at query 136, processing circuits 50 undertake an investigation 138 as to whether the requested resource is available. If the resource is available, processing circuits 50 ask at 140 whether the resource has passed a pre-assigned expiration date. If so, a signal is transmitted in a step 142 to the source of resource to determine if a newer version of the resource is available. If a new version is available, as ascertained at a decision junction 144, a request for the newer version of the resource is transmitted to the source in a step 146. This request is flagged as non-shutable and should be additionally flagged as a priority request.

Prior to the processing of an incoming packet, e.g., a user request for a code module,

processing unit 30 examines the header information in the incoming packet at an inquiry 150 to determine whether the packet contains user authentication information. Where user authentication information is found, the former encryption status of the packet is determined at 152. If the packet was not encrypted, a message is generated in a step 154 to report that the user authentication failed. If the incoming packet was encrypted, the MCMP header information is checked at 156 to determine if the source server is specified. If there is no source server specification, user authentication failure is reported in step 154. If there is a source server specified in the MCMP header information and if that source server is not the host server, as determined at a decision junction 158, an investigation 160 is conducted (by authentication code comparator 52) as to whether memory area 48 has a non-expired, cached copy of the user authentication data. If there is no non-expired, cached copy of the user authentication data in memory area 48, comparator 52 induces processing circuits 50 to obtain the user's authentication data from the source server and to store that data in memory area 48 (step 162). If a user's password contained in the MCMP packet header information does not match the cached password, as determined by comparator 52 in an evaluation 164 or if the user is not listed with the source server, as discovered by processing circuits 50 at a check point 166, the user authentication is reported as failed in a step 168. A report as to user authentication failure (step 154) is also made if the source server is the host server (decision junction 158) and if comparator 52 finds in an investigation 170 that the user authentication data in the packet header does not correspond to any user authentication data in memory area 48.

Once comparator 52 finds a match between the authentication code in an incoming packet and the user's authentication code in memory area 48, as determined in investigation 170 or in evaluation 164, or if the incoming packet did not contain a user authentication code,

then evaluation 171 determines whether the packet should be handled directly by the MCMP protocol, or by another protocol. If evaluation 171 determines that the packet should be handled by the MCMP protocol directly, then the packet is processed accordingly at a step 173 as illustrated in Fig. 5. If evaluation 171 determines that the packet should be handled by a specific protocol, then processing circuits 50 determine in a step 172 which protocol (e.g., CMXD, UDSCP, MDBP, DPP) is appropriate for handling the content of the packet. If a response is produced by processing unit 30 under the selected protocol or by the main MCMP protocol, as determined in an inquiry 174, that response is transmitted in a step 176 to the client that originally made the request. If there was a service handoff, that is, if the packet was shunted to the host server, then the response will be transmitted to a computer other than the computer from which the host received the packet. In a step 178, processing unit 30 begins processing the next packet in the queue or waits for a new packet to arrive.

As shown in Fig. 5, processing operation 173 includes an initial inquiry 116 into the type of packet. If the packet is an encryption packet, encryption/decryption unit 38 or 60 is activated in a step 118 to decrypt the packet using the appropriate decryption module or key. In a subsequent step 120, the packet encased in the data area of the encrypted packet is flagged as non-shutable and placed back into the MCMP incoming packet queue. If it is determined at inquiry 116 that the packet is not an encryption packet, an MCMP status report indicated an unknown packet type is issued in a step 122 and the packet is discarded. The functionality of the MCMP protocol may be enhanced at a later time by enhancing the process illustrated in Fig. 5 to include conditions for additional types of packets.

The Code Module Exchange Protocol (CMXP) handles dynamic downloading of executable code, program version control, client-to-client module exchange, virus and malicious program protection, data uploading, idle-time downloading, and code module

5 caching. These functions are variously performed in servers 14 and 22 by code module exchanger 40 and version detector 42 and in user computer 12 by code module exchanger 56, author identification comparator 66, and unidirectional data submission and collection circuit 86, as well as by various nondesignated generic processing circuits 50 and 70. The server-side portion of the CMXP protocol, as implemented in part by code module exchanger 40, handles the delivery of code modules and supporting resources such as graphic images and fonts.

Requests to the CMXP server and to code module exchanger 40 can reference a file, a portion of a file (such as a code module), or a portion of a code module or other supporting module. Because programs are broken down into separate code modules, these code modules can be delivered on an as-needed basis, eliminating the need to download an entire program before execution thereof can commence.

There are several ways of accommodating or incorporating an upgrade where programs are delivered piecemeal, module by module. If the old and new versions are completely compatible (for example, the new version was generated as the result a fix to a typographical error in a dialog box), the new modules can be merged with the old modules. Version information is stored on a per-file basis as well as a per-code-module basis. This means that code modules which were not changed in a version upgrade do not need to be downloaded again. If the old and the new versions are not compatible and cannot be merged, and the entire program has been cached locally or is still available from the server, the old version of the program can continue to execute until the next time the program is restarted. If the old and the new versions are not compatible and cannot be merged, and the old version of the program is no longer available in its entirety, the program should be immediately terminated and restarted using the new version code modules. The author of a program can override any of these update procedures by including a custom update module in the new version of the program.

This code module is downloaded (if necessary) and executed whenever a version conflict arises. Then, an election can be made to perform any of the above procedures or a custom procedure such as remapping the contents of the program's memory area so that they can be used by the new version.

5 Code modules and associated resources are cached by both user computers 12 and secondary servers 22. The caching rules can be incorporated into the CMXP protocol and/or the applications program itself. This allows custom caching rules to be built into an application, thus providing for special caching schemes and hybrid applications. When a code module download is in progress, the number of bytes completed is stored in the cache along
10 with the actual data downloaded. If a download is interrupted, it can resume where it left off at a later time.

Fig. 7 illustrates operations executed by digital processing circuits of processing unit 30 which are functionally modified in accordance with the CMXP protocol. The operations include a check on author identification. Generally, the author blacklist in memory area 68 of
15 user computers 12 is transmitted to the user computers from a server which undertakes maintenance operations to keep the list updated (Fig. 8).

As illustrated in Fig. 7, processing circuits 50 inquire at 180 whether an incoming packet constitutes a request for a resource. An affirmative answer to this inquiry leads to a further inquiry 182, as to whether the requested resource is available for anonymous access. If
20 the resource is restricted, a determination 184 is made as to whether the requesting user has rights to access the requested resource. If the user has no such rights, an "access denied" message is returned to the requester in a step 186. If the requested resource is available to the requesting party, processing circuits 50 determine at a decision junction 188 whether the requested resource contains executable code. An affirmative determination causes a query 190

as to the validity of the author's fingerprint. If the fingerprint or author identification is invalid, a message is generated for a responsible party in a step 192. The local copy of the resource is deleted in a subsequent step 194 and a message "Resource Distribution Prohibited" is transmitted to the requesting party in a step 196.

5 If in response to query 190 it is found that the fingerprint of the author of the requested resource is valid, then a check 198 is made as to whether the author is blacklisted. A blacklisting leads to deletion of the local copy of the resource in step 194 and the issuance of the message "Resource Distribution Prohibited" in step 196. If the author is not blacklisted, or if the requested resource does not contain executable code, as determined at decision junction 10 188, then the processing unit 30 queries at 200 whether the client already has an up-to-date copy of the resource. If the client or user already has the latest version of the resource, a message to that effect is transmitted in a step 202. If the client or user's copy of the resource is an older version, the requested resource is transmitted to the client in a step 204.

 If an incoming packet does not constitute a request for a resource, as ascertained in 15 response to an inquiry 180, an investigation 206 is made as to whether the packet constitutes a request to modify a resource. If so, and if the resource is not available for anonymous modification, as determined at a decision junction 208, then processing unit 30 queries at 210 whether the user has rights to modify the resource. If the user has no such rights, then a message "Access Denied" is returned to the requester in a step 212. If the resource is available 20 for modification by anybody (decision junction 208) or by the particular user (query 210), the processing unit 30 makes the requested modification to the resource in a step 214 and notifies key secondary servers, in a step 216, of the change to the resource.

 If an incoming packet does not constitute a request for a resource, as ascertained in response to inquiry 180, and is not a request to modify a resource, as determined in

investigation 206, then the processing unit 30 checks at 218 whether the packet is an update to a prohibition list, for example, a list of prohibited users or blacklisted authors. If the packet is such an update and is encrypted, as determined at decision junction 220, then the processing unit 30 determines at an inquiry 222 whether the packet was sent under the system user
5 account. If so, the cached copy of the prohibition list is updated in a step 224 and all secondary servers are notified of the update in a step 226. If an incoming update request is not encrypted (decision junction 220) or is not sent under the system user account (inquiry 222), then an alert message is issued to an appropriate party in a step 228. In a step 230, a special status report is issued if an unknown packet type is received.

10 In a CMXP maintenance loop, shown in Fig. 8, for updating a list of blacklisted authors, processing unit 30 asks in an initial query 232 whether the time since the last list update is more than a predetermined number of hours. If that much time has passed, an attempt 234 is made to contact the next server upstream of the server conducting the inquiry. If that server cannot be contacted, as determined in a scan 236, a check 238 is made as to
15 whether there are other servers available. If another server is available, an attempt 240 is made to contact that server. If no server can be contacted, the time is again checked, at 242. If a predetermined interval has lapsed since the last update, then an alert is provided to an appropriate party in a step 244.

If a server can be contacted, as ascertained in scan 236, the date of the last modification
20 of the prohibition list is obtained from that server in a step 246. In a comparison 248, the processing unit 30 then determines whether the prohibition list has been modified since the list was cached by the processing unit. Where such a modification has occurred, a copy of the prohibition list is obtained in a step 250. The encryption status of the obtained list is investigated at 252. If the copy of the prohibition list. Finding a nonencrypted copy of the

prohibition list leads to an alert status in a step 254, while an encrypted packet is investigated at 256 to determine with the packet was sent under the system user account. A properly sent packet results in an update of the cached copy of the prohibition list in a step 258 and a notification of the update to all servers in a step 260.

5 There are two primary methods for submitting or collecting data via the Uni-Directional Data Submission and Collection Protocol ("UDSCP"). Pursuant to the first method, submissions can be directed to either a primary server 14 or a secondary server 22. All submissions are then collected at a central server, where the submissions are processed by an application-specific server-side module. This method would be particularly useful for
10 collecting all form submissions on one server where they can be incorporated into a LAN-based mail system. In the second method, a submission can be again directed at either a primary server 14 or a secondary server 22. The submissions are collected on the servers to which they were originally submitted (or are shunted using the standard load collection rules). The submissions are then processed by an application-specific server-side module. This
15 module could, for example, e-mail all of the submissions to an Internet e-mail address.

Fig. 9 illustrates program steps undertaken by digital processing circuits of processing unit 30 which are functionally modified in accordance with the UDSCP protocol. These circuit handle data submissions transmitted from user computers 12, particularly from unidirectional data submission and collection circuit 90 of processing unit 54, and from other
20 servers. In a first inquiry 262, the processing unit 30 inquires whether an incoming packet is a data submission. If so, another inquiry 264 is made as to whether the data has to be collected immediately. If immediate collection is called for, the next question 266 entertained by the processing unit 30 is whether the data has to be collected at the source server. If not, the packet is passed in a step 268 through to a module that handles the final data collection. This

module handles e-mailing the submission, recording it in a database, writing it to a file, or performing any other necessary server-side task with the data. Subsequently, in an investigation 270, it is checked whether the request has been processed by the data collection module. If so, the packet is removed in a step 272 from the UDSCP submission processing queue, assuming that is where the packet was obtained. Then a status report is issued at 274 indicating successful data packet transmission. If investigation 270 reveals that the request has not been processed by the data collection module, the processing unit 30 questions at 276 whether the failure to process was due to a possibly temporary condition. If the answer to this question 276 is negative, a status report 278 is issued describing the error condition. If the answer to the question 276 is affirmative, a status report 280 is issued describing the condition and indicating the possibility of delay in processing the data. The packet is then added in a step 282 to the UDSCP processing queue.

If an incoming packet is a data submission which does not have to be collected immediately, as determined at inquiries 262 and 264, a status report 284 is issued indicating success and the packet is then added in a step 286 to the UDSCP processing queue. If an incoming data packet is a data submission which has to be collected immediately at the source server, as determined at inquiries 262 and 264 and in response to question 266, a check 288 is made as to whether the host server is the source server. If so, the packet is passed in step 268 through to a module that handles the final data collection. If not, processing unit 30 conducts an investigation 290 as to whether the source server can be contacted. If no contact is possible, a status report 292 is generated indicating that there will be a delay in processing the data and the packet is then added to the UDSCP processing queue in step 286. If the source server can be contacted, the data is transmitted to that server in a step 294. If the UDSCP function-modified generic processing circuits of processing unit 30 are provided with a packet

other than a data submission, a report is produced in a step 296 indicated that the packet is of unknown type.

Fig. 10 illustrates steps in a maintenance loop undertaken by generic digital processing circuits in processing unit 30 which are functionally modified in accordance with the UDSCP protocol. First, an inquiry 298 is made as to whether there are entries in the UDSCP submission processing queue. If so, the first entry is read in a step 300. Subsequently, processing unit 30 decides at junction 302 whether more than X seconds have passed since a date and time stamp on the entry. If not, the UDSCP submission processing queue is investigated at 304 to ascertain whether any further entries are in the queue. If so, the next entry is read in a step 306 and again the processing unit 30 decides at junction 302 whether more than X seconds have passed since a date and time stamp on the entry. If the time passed is greater than that predetermined limit, then a query 308 is made as to whether the server is too busy to handle the data submission. If the server is indeed too busy, processing unit 30 questions at 310 whether the data has to be collected immediately. If the data collection is not urgent, processing unit 30 determines at 312 whether the date and time stamp on the entry was earlier than a particular time. If the date and time stamp is recent, processing unit 30 returns to investigation 304 to check any remaining data submissions in the UDSCP submission queue.

If the server is not too busy to handle a data submission (query 308), if the data has to be collected immediately (question 310), or if data and time stamp indicates a certain age to the data submission (determination 312), processing unit 30 determines at a decision junction 314 whether the data has to be collected by the source server. If not, the packet is passed in a step 316 to a module that handles the final data collection. This module handles e-mailing the submission, recording it in a database, writing it to a file, or performing any other necessary

server-side task with the data. Subsequently, processing unit 30 checks at 318 whether the data submission was processed by the data collection module. If processing has indeed occurred, the packet is removed from the UDSCP submission processing queue in a step 320 and the processor 30 returns to investigation 304 to ascertain whether any further entries are in the queue. If the data submission packet has not been processed, which is discovered at 318, an inquiry 322 is made as to whether the failure to process the request is due to a possibly temporary condition. If not, a notification 324 is generated for alerting an appropriate person as to the failure. If so, the date and time stamp on the data submission is updated in a step 326.

- 10 If processing unit 30 determines at decision junction 314 that the data has to be collected by the source server and further determines at a subsequent decision junction 328 that the host (itself) is the source server, then the packet is processed (step 316). Alternatively, if the source server must do the data collection and is a different computer, as determined at decision junction 328, then an attempt 330 is made to contact the source server.
- 15 If the source server cannot be contacted, the date and time stamp on the data submission is updated in step 326. If the source server is available, the data submission is transmitted to the source server in a step 332 and the packet is removed from the UDSCP processing queue in a step 334.

As discussed above, the MCMP protocol handles Load Distribution, User

20 Authentication, and Encryption. All other functions are handled by sub-protocols. The MCMP protocol has four sub-protocols. These are the Code Module Exchange Protocol (CMXP), the Uni-directional Data Submission and Collection Protocol (UDSCP), the Metered Delivery and Billing Protocol (MDBP), and the Distributed Processing Protocol (DPP). This set of protocols can be expanded in the future to add additional functionality to the MCMP protocol.

Basic MCMP Packet Structure

All MCMP packets consist of a MCMP header, followed optionally by one or more resource identifiers, and a data area called the *packet body* (Fig 1). The entire size of an MCMP packet can be calculated as $128 + \text{RsrcIDLen} + \text{PacketSize}$, where RsrcIDLen and

5 PacketSize are elements of MCMP header (see below).

The MCMP header identifies the sub-protocol to which the packet belongs, as well as the type of packet. In addition, the MCMP header contains load distribution, user authentication, and encryption information. The Resource identifiers identify any resource or resources referred to in the packet (the ResourceReq flag being set). The MCMP packet body
10 contains packet-type specific information and is always interpreted by a subprotocol handle. The packet body is optional and can be omitted by setting the PacketSize element of the MCMP header to be 0.

The MCMP header structure is defined as:

	MCMPHeader, 128	\$\$ MCMP header structure
15	· MPVersion, 4	\$\$ Master protocol version
	· ProtoVendor, 8	\$\$ Protocol vendor
	· ProtoID, 8	\$\$ Protocol ID
	· ProtoVer, 4	\$\$ Protocol version
	· TransID, 2	\$\$ Client Assigned Transaction-ID
20	· PacketType, 2	\$\$ Protocol-specific Packet Type
	· PacketVersion, 4	\$\$ Packet version number
	· PacketSize, 4	\$\$ Size, in bytes, of packet body
	· OrigIP, 4	\$\$ Originating Host IP Address
	· OrigPort, 2	\$\$ originating Host Port Number

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	· UserID,10	\$\$ User ID for client authentication
	· Password, 10 -	\$\$ Password for client authentication
	· RsrcIDLen,2	\$\$ Resource identifier length
	· RsrcIDs,2	\$\$ Number of resource identifiers
5	· RsrcSrcIP,4	\$\$ Resource source IP
	· Flags, 2	\$\$ Flags; see functions below
	· , 64	\$\$ Reserved

* Flags:

10	Shunted = bit (Flags,1)	\$\$ Packet has been shunted
	Shunable = bit (Flags,2)	\$\$ Packet can be shunted
	Encrypted = bit (Flags,3)	\$\$ Packet was encased in an encryption packet
	ResourceReq = bit (Flags,4)	\$\$ Packet constitutes a request for a resource

The elements of this structure are described in more detail below.

15 MPVersion: This is a 4-character version identifier for the Master Protocol. If the structure of the MCMP header or any other major component of the Master Protocol structure is revised, this version number is incremented.

ProtoVendor: This is an 8-byte text literal that describes the software vendor initial responsible for maintaining the sub-protocol specification for the sub-protocol to which the
20 packet belongs.

ProtoID: This is an 8-byte text literal assigned by the software vendor specified in the ProtoVendor element. This identifies the sub-protocol to which the packet belongs. The combination of ProtoVendor and ProtoID uniquely identifies a sub-protocol.

ProtoVer: This is a 4-byte text string that specifies the version of the sub-protocol specified in the ProtoVendor and ProtoID elements. The first to characters are the major version, the second two the minor version. All characters must be used, so if the major version is one character long, it must be written as 01, not 1. This value does not contain a decimal point. For example, version 2.4 would be 0 2 4 0.

Packet-Type Identifier (PacketType): A two-byte integer assigned by the vendor that uniquely identifies the packet type within a particular sub-protocol.

PacketVersion: This is a 4-character identifier for the packet version. When the structure of a packet is changed, this version number is incremented. This allows a sub-protocol handler running on an MCMP server to deal with both old and new packet structures, should a packet structure need to be altered. The format for the string is the same as the format of the ProtoVer element of the MCMP header.

Shunted flag (Shunted): A flag indicating whether this packet has been shunted as the result of a service hand off.

Shunable flag (Shunable): A flag indicating whether this packet can be shunted. This flag and the Shunted flag are mutually exclusive.

Encrypted flag (Encrypted): A flag indicating whether the packet was encrypted. This flag is cleared when a packet is placed in the MCMP Server incoming packets queue, unless the packet is place there by the decryption system, in which case the flag is set.

Request-Resource flag (ResourceReq): Indicates whether the packet constitutes a request for a resource.

Number of Resource Identifiers (RsrcIDs): Dpecifies the number of resource identifiers following the MCMP header structure.

Resource Identifier Length (RsrcIdLen): Specifies the combined length of all resource

identifiers following the MCMP Header structure.

Originating Host Address (OrigIP, OrigPort): This is the IP address of the host from which the request originated. If the packet was shunted, this is the IP address of the host that originally transmitted the request, not the address of the server that forwarded the request.

- 5 Resource Source IP (RsrcSourceIP): This is the IP address of the host on which the original copy of the requested resource resides, if the Request-Resource flag is true.

 Cached Copy Date/Time Stamp (CacheDate, CacheTime): This is the date and time stamp of the cached copy of the resource, or zero if no cached copy exists. If the date and time stamp of the resource match this date and time stamp, the resource content will not be
10 returned.

 Size of packet body (PacketSize): The size (in bytes) of the packet body following the MCMP Header and (if present) the resource identifiers.

- User ID and Password for client authentication (UserID, Password): A user ID and Password used to authenticate the client. The authority for a user's ID and Password is the
15 Resource Source IP server. If a request is made to a secondary server for a password-protected resource, the secondary server must check with the primary (or source server) for password authentication. This information can be cached for the duration of the session.

- Transaction ID (TransID): A unique ID assigned by the host initiating the transaction.
20 This is used to track a transaction over one or more service hand-offs. For an encryption packet, this should be set to zero (although it can be set to a non-zero value in the encased packet).

MCMP Resource Identifiers

If the packet refers to one or more resources (the ResourceReq flag is set), the

Resource identifiers identify the resource or resources to which the packet refers. Resource identifiers are null-terminated text strings. The basic format for a resource identifier is:

- type:[locator/s:]length[:date[,time]]

Where:

5	type	Identifies the resource type; the possible values for this argument are sub-protocol-specific.
	locator/s	One or more values (in double-quotes if they contain commas; double up the double-quotes where they are used within the value) used to locate the resource.
10	length	The amount of the resource to read (in units specific to the sub-protocol). This is always the last item in the resource identifier. It can be in the format " <i>n</i> " to specify <i>n</i> units starting at the beginning of the resource, the format " <i>n/n</i> " to specify a range of units (inclusive), the format " <i>n-n</i> " to specify a starting unit and number of units, or "*" to specify the entire resource.
15	date	The date, in the format mm/dd/yyyy that the cached copy of the resource was last modified. This field accepts both single and double digits for the month and day, although the year must be specified as a full 4-character string. Forward-slashes must be used as separators.
20	Time	The time, in the 24-hour format hh:mm:ss, that the cached copy of the resource was last modified. hh may be a single or double digit number, and mm and ss must be double digit numbers (use a leading zero if necessary).

The Resource ID is optional, and does not need to be included in a MCMP packet, so long as the ResourceReq flag is not set.

Some example Resource ID's are:

data:"\catharon\demos\media.", "video.bin", "play30";*

5 prohibitedlist:*

dir:"\";*

data:"\catharon\demos\", "mag2.dat";0/256

data:"\training", "air.bin.", "Rudder";*,10/03/1995,4:03:30

MCMP Packet Types

10 The following subprotocols are not sub-protocol specific and are accordingly defined for the MCMP protocol:

	MCMP_Encrypt	= h0002	\$\$ Encryption
	MCMP_Status	= h0003	\$\$ Status Report
	MCMP_PerfStatReq	= h0006	\$\$ Performance Statistics Request
15	MCMP_PerfStatResp	= h0007	\$\$ Performance Statistics Response
	MCMP_UserIReq	= h0008	\$\$ User Information Request
	MCMP_UserIResp	= h0009	\$\$ User Information Response
	MCMP_EchoReq	= h000a	\$\$ Echo Request
20	MCMP_EchoResp	= h000b	\$\$ Echo Response

These packet types are described in detail below.

ENCRYPTION (MCMP_Encrypt): The encryption packet is used when data must be encrypted. A packet to be encrypted is encased in the data area of a MCMP System encryption packet. The MCMP Header for the encryption packet is:

48

PacketType: MCMP_Encrypt (hO002)
 PacketSize: Size of encased packet in encrypted form plus 32 bytes
 ResourceID's: None
 Shutable: Inherited from encased packet
 5 ResourceReq: False

The packet body of the encryption packet is:

Bytes 0-31 Encryption header
 Bytes 32-end Encrypted packet

The header for the encryption packet is:

10 PT_Encrypt_Header,32
 · DecryptLess,8 \$\$ Code module to handle decryption
 · DecryptUnit,8
 · EncodingMethod,2 \$\$ Encoding method
 · ,14 \$\$ Reserved

15 STATUS REPORT (MCMP_Status): The status report packet is used to return the status of an operation. When used, it is always a response to a previously transmitted request. The status packet contains detailed error information, including an English language description of the error or status value which can be displayed by the application if it cannot interpret the error code.

20 A status report packet body consists of one or more information fields, which can vary in length. The first information field is always a Status Report Header. Each information field consists of an 8-byte header which indicates the length and type of the information field, followed by the field itself.

The MCMP Header for the status report packet is:

49

PacketType: MCMP_Status (hO002)

PacketSize: Variable

ResourceID's: None

Shunable: No

5 ResourceReq: No

The Information Field Header for the status report packet is:

MCMP_StRprt IFldHdr,8

- IfldSize,2 \$\$ Size of information field
- IfldClass,1 \$\$ Field class (1=Standard, 2=Protocol Specific)
- 10 · IfldType,2 \$\$ Field type
- , 3 \$\$ Reserved

Following are the standard information field types (where IFldClass=1):

- MSR_Header = 1 \$\$ Header
- MSR_ShortDesc - = 2 \$\$ Short Description
- 15 MSR_LongDesc = 3 \$\$ Long Description
- MSR_DetailDesc = 4 \$\$ Detailed Description (Technical)
- MSR_XErr70 = 102 \$\$ LAS 7.0 Execution Error Data
- MSR_XErr70do = 103 \$\$ LAS 7.0 Execution Error-do-stack

These information field types are described in detail below:

20 The generic status report header (MSR_Header) is always present in all status report packets, and is always the very first information field in the packet. It has the following structure:

MSR_Header_Struc,32

ProtoVendor, 8 \$\$ The Vendor of the protocol reporting the error

50

- ProtoID, 8 \$\$ The ID of the protocol reporting the error
- ProtoVer, 4 \$\$ The version of the protocol reporting the error
- Severity, 1 \$\$ severity of error:
 - * -1 = Notification of success
 - 5 · * 0 = Warning (operation will proceed anyway,
but there may be a problem)
 - * 1 = Error (operation cannot proceed)
 - * 2 = Unexpected error
- ProtoSpecific, 1 \$\$ Protocol-specific error-flag.
- 10 · ErrorType, 2 \$\$ Sub-Protocol-Specific error type
- ErrorCode , 2 \$\$ Sub-Protocol -Specific error code
- , 6 \$\$ Reserved

If the ProtoSpecific flag is set, then ErrorType and ErrorCode are protocol-specific.

Otherwise, ErrorType is one of the following:

- 15 ERRT _ Zreturn = 1 \$\$
- *zreturn* error
- ERRT_XErr = 2 \$\$ TenCORE Execution error
- ERRT_CErr = 3 \$\$ TenCORE Condense error
- ERRT_Dosdata = 4 \$\$ Catharon dosdata-style error

- 20 For anything in the MCMP_Status packet that is protocol specific, the ProtoVendor and ProtoID from the Status Report Header are used to identify the protocol.

The Short Description information field type (MSR_ShortDesc) is a short description of the error, 40 characters long or shorter, that can be used in a list or wherever a brief, friendly error description is needed. This packet is 40 bytes long, and is structured as follows:

MSR_ShortDesc sttlc, 40

ShortErrDesc, 40

\$\$ Short description of error

The Long Description information field type (MSR_LongDesc) is a longer description of the error, which can vary in length up to 2048 characters. This description can span

5 multiple lines, with each line terminated by a carriage return (h0d). The length of this description is determined by the length of the information field, and the entire content of the information field is one long buffer variable containing the description as text. There is no maximum length to a line, and lines may be word-wrapped at any position when this description is displayed.

10 The Detailed Description information field type (MSR_DetailDesc) is a detailed technical description of the error, with all diagnostic error information included. For example, this might be a standard TenCORE execution error as it would be written to the catharon.err log file by the Catharon error handler. This can vary in length, up to 4096 characters. The description can span multiple lines, with each line terminated by a carriage return (h0d). Lines
15 must be no longer than 80 characters. Lines longer than 80 characters may be truncated at display time. This description is never word-wrapped, and is always displayed in a fixed pitch font, allowing items on separate lines to be aligned and formatted using spaces (tables could be created using this method). The length of this description is determined by the length of the information field, and the entire content of the information field is one long buffer variable
20 containing the description as text.

The TenCORE 7.0 Execution Error Data (MSR_XErr70) is an exact snapshot of the data generated by a TenCORE execution error, and returned by TenCORE in the execution error memory block. It is 256 bytes long. This information field type is normally only included if the error being reported is a TenCORE execution error.

The TenCORE 7.0 Execution Error To- Stack (MSR_XErr70do) is an exact snapshot of the TenCORE execution error -do- stack. The size of the data varies based on the size of the TenCORE -do- stack at the time of the error.

PERFORMANCE STATISTICS REQUEST (MCMP_PerfStatReq): The performance
5 statistics request packet requests a server's current performance and load statistics.

The MCMP Header of a performance statistics request is:

10	PacketType:	MCMP_PerfStatReq (h0005)
	PacketSize:	0
	ResourceID's:	None
	Shutable:	No (because this is a request for the statistics for the server to which it is addressed, shunting me packet would cause meaningless results)

The response to this packet should be either an MCMP_PerfStatResp or a
MCMP_Status packet.

15 PERFORMANCE STATISTICS REPORT (MCMP_PerfStatResp): This packet is a
response to an MCMP_PerfStatReq packet and contains a performance statistics report for the
server to which it was addressed.

The MCMP Header of a performance statistics report is:

20	PacketType:	MCMP_PerfStatReq (h0006)
	PacketSize:	32
	ResourceID's:	None
	Shutable:	No
	ResourceReq:	No

The Packet Body of a performance statistics report is:

53

PerfStats,32

	•	Pusage,1	\$\$ Processor usage (percent)
	•	CurReqs,2	\$\$ Current number of requests being processed
	•	TotalReqs,2	\$\$ Total number of requests the can be processed
5	•	ShuntReqs,2	\$\$ Threshold, in requests, at which shunting begins
	•	PmemTotal,4	\$\$ Total physical memory on system
	•	PmemUsed,4	\$\$ Used memory on system
	•	VmemTotal,4	\$\$ Total virtual memory on system
10	•	VmemUsed,4	\$\$ Used virtual memory on system
	•	AreqPMethod,1	\$\$ Current method for processing additional requests
	•	,8	\$\$ Reserved

The elements of the packet body structure are, in detail:

15 PUsage: Current processor usage percentage (0% to 100%). Set to -1 if processor
usage percentage is not available.

CurReqs: Approximate number of requests currently being processed.

TotalReqs: Total number of requests that can be processed at one time.

ShuntReqs: Maximum number of requests before shunting occurs. This is usually less
20 than TotalReqsto allow some extra system resources for the purpose of shunting requests.

PmemTotal: Number of bytes of physical memory on server, or -1 if amount not
known.

PmemUsed: Number of bytes of physical memory that have been used, or -1 if amount
not known.

VmemTotal: Number of bytes of virtual memory available on server, -1 if not known.

VmemUsed: Number of bytes of virtual memory in use, or -1 if not known.

AreqPMethod: Method that will be used by the server deal with new incoming requests, based on the other statistics in this packet. This can have the numerical value 1, 2, or
 5 3. 1 indicates that new requests will be processed normally; 2 indicates that new requests will be shunted; 3 indicates that new requests will be refused.

USER AUTHENTICATION INFORMATION REQUEST (MCMP_UserIReq): This packet requests user authentication information on a particular user. This packet must be encrypted, and is sent only from a secondary server to a primary server. The receiving server
 10 must check that the sender is listed as a secondary server before responding to this request.

The expected response is either an MCMP_Status packet or an MCMP_UserIResp packet.

This packet uses a special type of resource identifier, which is defined as follows:

type:user[,uadbitem];length[:date,time]

15 Where:

type	Identifies the resource type; is always "useradb"
user	The name of the user in question
uadbitem	Path to user authentication database item to retrieve. If omitted, a tree-file is resumed containing the entire user authentication 20 data tree for the specified user. The root of the resumed tree-file is equivalent to \LocalUsers\username in the user database file. length Portion of item to be resumed.

Examples:

useradb:JohnS.\Catharon\RAdmin\Rights;*:03/13/1995,12:20:48

useradb:HugoC;*

useradb:JDouglas,\XYZWidSt\WDBP\GroupMembership;256;S/12/1996, 01:00:30

The User Authentication Database (UADB) is stored in a tree-file. User information is stored in \LocalUsers. Inside the \LocalUsers folder are folders for each user, named based on the user's ID. In each user's folder are folders for each vendor (i.e. "Catharon", "CTC", etc.), and inside the vendor folders are folders for each protocol defined by that vendor. The contents of a protocol folder are protocol-specific. The path specified in the resource ID is rooted at \LocalUsers\username.

Basic user authentication information is stored in \Catharon\MCMP\BaseAuthData.

10 This is structured as follows:

UserAuthData,32

- UserID,10 \$\$ Userts name/ID
- UserPass,10 \$\$ User's password
- ExpTime,3 \$\$ Time, in seconds, before data
- 15 · \$\$ expires (10 to 864000).
- BinUID,4 \$\$ Binary User ID
- ,5 \$\$ Reserved

If a secondary server sends a request in the form:

useradb:usez,2ame,*[:date,time]

20 the entire user authentication tree is retrieved for the specified user. The ability to read a specific item from the user authentication tree is provided for future use and expandability.

After retrieving user authentication data, that data can be cached for the period of time specified in the ExpTime element of the UserAuthData structure. The user authentication data may not be cached longer than the specified time.

The MCMP Header of the User Authentication Information Request is:

PacketType: MCMP_UserIReq (h0008)
 PacketSize: 0
 ResourceID's: One; specifying the user to retrieve information about,
 5 and what information to retrieve.
 Shutable: No (must be processed by primary server because the
 primary server is the only authoritative source of
 information on the user).
 ResourceReq: Yes

10 USER AUTHENTICATION INFORMATION RESPONSE (MCMP_UserIResp):

The response to an MCMP_UserIReq packet, this packet contains the requested information in its data area. This data is either the raw data read from the requested data block in the user database, or (if uadbitem is omitted) is a tree file containing the entire user information tree for the specified user, with the root of the file being equivalent to \LocalUsers\username in the

15 UADB.

The MCMP Header of the User Authentication Information Response is:

PacketType: MCMP_UserIResp (h0009)
 PacketSize: Variable
 ResourceID's: None
 20 Shutable: No
 ResourceReq: No

ECHO REQUEST (MCMP_EchoReq): This packet is used to time the connection to a particular MCMP host. When this packet is received by an MCMP host, a MCMIP_EchoResp packet is immediately sent back. The data area can contain any data, up to a maximum size of

2048 bytes. The return packet's data area will contain the same data.

The MCMP Header of the Echo Request is:

	PacketType:	MCMP_EchoReq (hOOOa)
	PacketSize:	Any
5	ResourceID's:	None
	Shuntable:	No
	ResourceReq:	No

ECHO RESPONSE (MCMP_EchoResp): This packet is sent in response to an MCMP_EchoReq packet.

10 The MCMP Header of the Echo Response is:

	PacketType:	MCMP_EchoResp (hOOOb)
	PacketSize:	Same as original MCMP_EchoReq packet
	ResourceID's:	None
	Shuntable:	No
15	ResourceReq:	No

Some files in a directory may support additional access pennission information. For example, a tree file could contain information on access permission for individual units within the tree file.

CMXP Resource Identifiers

20 Resource Identifiers for CMXP packets are defined as follows:

type:patht,file[,unit]];length[:date,time]

Where:

type Identifies the resource type. This can be either "Data" to read data from the specified resource, or "Dir" to read a directory of contained

resources.

path Path to a directory...must be at least a backslash "\". If file and unit are not specified, the directory is considered the resource to be read; otherwise, the file or unit referenced is assumed to be located in the specified directory. If file and unit are not specified, then type must be "Dir".

file A filename. If unit is not specified, the file is considered the resource; otherwise, the unit is assumed to be located in the specified file. A file resource can be accessed with both the "Dir" and "Data" resource types; "Dir" will reference the list of contained units, while "Data" will reference the actual data contained in the file.

unit A unit name. If specified, the unit is considered to be the resource. This can be accessed with both the "Dir" and "Data" resource types; "Dir" will reference the list of sub-units, while "Data" will access the data contained in the unit.

length The portion of the resource to read. If type is "Data", this value is in bytes. If type is "Dir", this value is in directory entries.

date/time Can only be specified in a request packet. Causes the recipient process to ignore the request unless the resource has been modified since the date/time specified. This can be used in conjunction with the CMXP_ReadReq packet to request that a resource be sent only if it has changed since it was cached on the client.

CMXP Packet Types

The following is a list of the packet types used by the CMXP protocol at this time. The

functionality of the CMXP protocol can be expanded in future by adding to this list of packet types.

CMXP_ReadRsrcReq = h0002

CMXP_ReadRsrcResp = h0003

5 CMXP_WriteRsrc = h0004

CMXP_CreateRsrc = h0005

CMXP_DestroyRsrc = h0006

CMXP_RenameRsrc = h0007

CMXP_CopyRsrc = h0008

10 CMXP_MoveRsrc = h0009

CMXP_AltSListReq = h000a

CMXP_AltSListResp = h000b

These packet types are described in detail below.

15 READ RESOURCE REQUEST (CmxP_ReadRsrcReq): This packet is a request to read one or more resources. It is sent from a client to a server to download a resource, sent from a client to a client to request a code module transfer for a plug-in module, or sent from a server to a server to request transfer of the appropriate resource to service a client request. A CMXP_ReadRsrcReq packet can request either resource content, resource information, or both. Because the definition of a resource includes file directory and code module directories, 20 this packet can also be used to request a list of files in a directory or code modules in a file.

This packet is responded to with a series of packets (one for each request resource). These packets are either CMXP_ReadRsrcResp (if the resource was successfully read) or MCMP_Status (if there was an error reading the resource).

The MCMP Header of a read resource request packet is:

60

PacketType: CMXP_ReadRsrcReq (honey)

PacketSize: 32

ResourceID's: One or more, Identifying resources to read

Shuntable: Yes

5 ResourceReq: Yes

The Packet Body of a read resource request packet is:

ReadRsrcReqHeader,32

RHFlags,2 \$\$ Flags

,30 \$\$ Reserved

10 * Flags:

IncludeInfo = bit(RHFlags,1) \$\$ Include resource information

IncludeData = bit(RHFlags,2) \$\$ Include resource content

IdlePreCache = bit(RHFlags,3) \$\$ Request is the result of an idle-time
pre-caching operation.

15 The elements of the packet body are, in detail:

IncludeInfo: If set, this flag causes information about the resource to be returned.

IncludeData: If set, this flag causes the resource content to be returned.

IdlePreCache: If set, indicates the the request is the result of an idle-time pre-caching operation initiated by the client without user involvement. A CMXP server processes packets
20 with this flag clear before packets with this flag set are processed. When the load on a CMXP server becomes too high for it to deal with all requests, and it can not shunt requests, requests with this flag set will be dropped before requests with this flag clear.

IncludeInfo and IncludeData can both be set in the same request. In this case, the response is the resource information followed by the resource content. This is the most

common request type. At least one of these flags must be set in each request packet

READ RESOURCE RESPONSE (CMXP_ReadRsrcResp): Sent in response to a CMXP_ReadRsrcReq packet, this packet contains the requested information. Note that this packet is never sent in response to a CMXP_ReadRsrcReq if an error condition exists; instead,
5 a MCMP_Status packet is sent.

Depending on the state of the IncludeInfo and IncludeData flags in the CMXP_ReadRsrcReq packet, the packet body may contain resource information and/or resource content. The resource information, if it is present, always comes first in the packet body, followed by the resource content, if present. The size of the resource information can be
10 determined by reading the ResourceInfoSize element of the version of a program can be successfully merged with code modules from an old version of the program.

RsMaxSubs: The maximum number of subsidiaries that the resource can contain.

RaSizeAInfo: The size, in bytes (1 to 8), of the associated information for the resource (RsAInfo).

15 RsSizeSubName: The maximum length, in characters, of the name of a subsidiary of the resource.

RsHeight, RsWidth: The height and width of the bounding rectangle of the resource at its default scaling, if applicable. This is used for object-based drawings, images, etc.

RsPTime: The playing time, in seconds at the default playing speed, of the resource (if
20 applicable); used for video clips, wav files, midi files, animations, etc.

WRITE RESOURCE (CMXP_WriterSrc): This packet writes data to the specified resource. This requires sending a packet to the primary server that cannot be shunted, so this can increase server load. For form submissions and other uni-directional submissions, the UDSCP protocol is recommended over the write functions of the CMXP protocol.

A CMXP_WriteRsrc request may fail due to, among other things, the fact that the user is not allowed to write to the specified resource. This situation may be remediable by repeating the request with a user-id and password specified (in this case, the request must be encased in a MCMP_Encrypt packet).

- 5 There are two variations of the status code returned when access is denied due to failed user authentication. One variation indicates that the client should prompt for a user name and password. This is a "hint" to the client that the resource may be accessible via a user name and password. It is not conclusive. In other words, the variation on the Access Denied code does NOT indicate whether access is really available to anyone; i just indicates whether the client
- 10 should ask. There may, for example, be a resource designed to be accessed under program control, and not under user control, which requires user authentication of an "automation user", and which denies access the rest of the time without even prompting for a user-id/password.

The packet body contains the data to be written to the resource.

- 15 The MCMP Header of the write resource packet is:

PacketType:	CMXP_WriteRsrc (h0004)
PacketSize:	Variable
ResourceID's:	One; the ID of the resource to-wnte to
Shutable:	No
20 ResourceReq:	Yes

CREATE RESOURCE (CMXP_CreateRsrc): This packet creates a subsidiary in the specified resource. This includes files, directories, and units. The same rules regarding user authentication apply to this packet as apply to the CMXP_WriteRsrc packet.

The MCMP Header of the create resource packet is:

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PacketType: CMXP_CreateRsrc (h0005)

PacketSize: Variable

ResourceID's: One; the ID of the resource In which to create the new subsidiary.

5 Shutable: No

ResourceReq: Yes

The Packet Body of the create resource packet is:

NewRsrc,300

	·	RsSize,4	\$\$ Size, in bytes, of resource
10	·	RsAInfo,8	\$\$ Associated information (if applicable)
	·	RsMaxSubs,2	\$\$ Maximum number of subsidiaries
	·	RsSizeAInfo,1	\$\$ Size, in bytes, of associated information
	·	RsSizeSubName,2	\$\$ Maximum length of a subsidiary's name
	·	RsName,256	\$\$ Resource Name
15	·	RsName2,8	\$\$ Secondary Resource Name
	·	RsType,8	\$\$ Resource type
	·	,11	\$\$ Reserved

The elements of the packet body are, in detail:

ReSise: The size, in bytes, of the new resource. If creating a TenCORE nameset or

20 dataset, this must be a multiple of 256 bytes, and is equivalent to the *records* argumen of the -createn- commnand multiplied by 256 (to convert from records to bytes). When creating new directories, this is ignored.

R-AInfo: Associated information for the resource, if applicable (see CMXP
_CreateRsrc above)

RsMaxSubs: The number of subsidiaries allowed in the resource, if applicable. This is required for TenCORE namesets, and is equivalent to the names argument of the -createn- command. In most cases, when not dealing with TenCORE namesets, this is ignored.

R-SizeAInfo: The size of the resource's associated information. For namesets, this is
5 equivalent to the infolength argument of the -createn- command.

RsSizeSubName: Maximum length of a subsidiary's name. For TenCORE namesets, this is equivalent to the namelength argument of the -createn- command. In most cases when-not dealing with TenCORE namesets, this is ignored.

ReName: The name of the resource to create. The length of this name and the rules for
10 allowed characters depend on the type of resource being created.

RaName2: This is a secondary name for the resource. It is not currently used, but is provided for future use. This may be used, for example, to specify a short file name alias to go with a long filename in Windows 95/NT.

RaType: This specifies the type of resource being created. Note that not all resource
15 types are necessarily valid for all possible resources in which they could be created (i.e., one cannot create a file inside of a unit). Where only one resource type is possible for a particular containing resource, the value 'default' is used (for example, the only type of resource that can be created inside a TenCORE nameset is a block). This value is an 8-byte text literal.

The following resource types are currently defined for the CMXP protocol:

20	course	A course file (TenCORE nameset with .CRS extension)
	group	A group file (TenCORE nameset with .GRP extension)
	nameset	A gentral purpose nameset file (TenCORE nameset with .NAM extension)
	roster	A roster file (TenCORE nameset with .RTR extension)

	source	A source file (TenCORE nameset with .SRC extension)
	studata	A student data file (TenCORE nameset with .SDF extension)
	tptr	A Producer file (TenCORE nameset with .TPR extension)
	binary	A binary file (TenCORE nameset with .BIN extension)
5	file	An operating system file
	dir	An operating system folder or directory
	dataset	A TenCORE dataset
	tree	Catharon tree-file
	default	The default type for the container
10	block	A data block (in a nameset or tree-file)
	folder	A folder (in a time-file)

DESTROY RESOURCE (CMXP_DestroyRsrc): This packet destroys the specified resource. The same rules regarding user authentication apply to this packet as apply to the CMXP_WriteRsrc packet. The MCMP Header of this packet is:

15	PacketType:	CMXP_DestroyRsrc (h0006)
	PacketSize:	0
	ResourceID's:	One; the ID of the resource to destroy
	Shunable:	No
	ResourceReq:	Yes

20 RENAME RESOURCE (CMXP_RenameRsrc): This packet renames the specified resource. The same rules regarding user authentication apply to this packet as apply to the CMXP_WriteRsrc packet. The packet body contains the new name for the resource. The MCMP Header of this packet is:

PacketType:	CMXP_RenameRsrc (h0007)
-------------	-------------------------

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PacketSize: 272
 ResourceID's: One; the ID of the resource to rename
 Shutable: No
 ResourceReq: Yes

5 The Packet Body of the rename resource packet is:

RenameRsrc,272

· ResourceName,256 \$\$ New name for resource
 · ResourceSecondaryName,8 \$\$ Secondary name for resource (if
 applicable)
 10 · ,9 \$\$ Reserved

COPY RESOURCE (CMXP_CopyRsrc): This packet copies the specified resource.

The same rules regarding user authentication apply to this packet as apply to the CMXP_WriteRsrc packet. The MCMP Header of the copy resource packet is:

15 PacketType: CMXP_CopyRsrc (h0008)
 PacketSize: 0
 ResourceID's: Two; the first is the location of the resource to copy, the
 second the location to create the new copy of the
 resource.
 Shutable: No
 20 ResourceReq: Yes

MOVE RESOURCE (CMXP_MoveRsrc): This packet moves the specified resource.

The same rules regarding user authentication apply to this packet as apply to the CMXP_WriteRsrc packet. The MCMP Header of the move resource packet is:

PacketType: CMXP_MoveRsrc (h0009)

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PacketSize: 0

ResourceID's: Two; the first is the old location of the resource, the second the new location for the resource.

Shuntable: No

5 ResourceReq: Yes

ALTERNATE SERVER LIST REQUEST (CMXP_AltSListReq): This packet requests a list of secondary servers available for the specified resource. The server should respond with an CMXP_AltSListResp packet, except in the case of an error, in which case an MCMP_Status packet should be returned. The MCMP Header of this packet is:

10 PacketType: CMXP_AltSListReq (h000a)

PacketSize: 0

ResourceID's: One - The resource for which to list secondary servers.

Shuntable: Yes

ResourceReq: Yes

15 ALTERNATE SERVER LIST RESPONSE (CMXP_AltSListResp): This packet is sent in response to an CMXP_AltSListReq packet and contains the list of alternate servers. The MCMP Header is:

PacketType: CMXP_AltSListResp (h000b)

PacketSize: Variable

20 ResourceID's: None

Shuntable: No

ResourceReq: No

The Packet Body of the CMXP_AltSListResp packet is:

AltSList(nn), 16

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- IP,4 \$\$ IP Address of server
- Port, 2 \$\$ Port on server to access
- Load, 1 \$\$ Last known load on server
- Ping,4 \$\$ Last known ping-time to server
- 5 · ,4 \$\$ Reserved

UDSCP Packet Types

The following is a list of the packet types used by the UDSCP protocol at this time. The functionality of the UDSCP protocol can be expanded in future by adding to this list of packet types.

- 10 UDSCP_Submission = h0002
- UDSCP_QueueStatusReq = h0003
- UDSCP_QueueStatusResp = h0004

These packet types are described in detail below.

- DATA SUBMISSION (UDSCP_Submission): This is the primary packet type for the
- 15 UDSCP protocol. It is generated by a client, and then forwarded from server to server until it reaches the collection point. The packet body consists of a UDSCP Header followed by the content of the submission.

The MCMP Header of the data submission packet is:

- PacketType: UDSCP_Submission (h0002)
- 20 PacketSize; 32 + Size of data being submitted
- ResourceID's: None
- Shuntable: Yes
- ResourceReq: No

The UDSCP Header is:

UDSCPSubmitHeader,32

	HeaderSize,2	\$\$ Size of UDSCPSubmitHeader
	DataSize,4	\$\$ Size of data being submitted
	Cmethod,1	\$\$ Collection method (1=Central, 2=Secondary)
5	CpointIP,4	\$\$ Collection point IP Address
	Priority, 1	\$\$ Priority (0=low, 1=normal, 2=urgent)
	Lesson,8	\$\$ TenCORE Lesson/Unit to process submission
	Unit,8	
	Flags, 2	\$\$ Flags
10	,2	

* Flags:

Forwarded = bit(Flags,1) \$\$ Submission has been forwarded by a server

The elements of the UDSCP header are described in detail below:

HeaderSize: The size, in bytes, of the UDSCPSubmitHeader structure. This value
 15 should be read to determine the size of the whole structure, this allowing the structure to be
 expanded in future without affecting existing code.

DataSize: The size, in bytes, of the content of the submission following the UDSCP
 Header.

Cmethod: The collection method to be used. This is an integer value. A setting of 1
 20 causes data to be collected and processed at a central server, while a setting of 2 allows data
 to be processed on secondary servers.

CpointIP: The IP address of the collection point (central server). This is ignored if
 CMethod=2.

Priority: The priority of the submission. This is an integer value, and can be either 0 for

low, 1 for normal, or 2 for high priority. UDSCP servers attempt to process high priority submissions immediately, while normal and low priority submissions are held in the UDSCP submission queue and processed when the server would otherwise be idle. If a normal or low priority remains in the UDSCP queue for longer than the user configurable time limit, the server will attempt to process it immediately regardless of load or, failing to do so, notify a responsible person. The time limits for low and normal priority submissions are configurable separately, and low priority submissions are usually configured for a longer timeout.

Lesson, Unit: The names of the TenCORE lesson and unit that will process the submission.

Forwarded: This flag is set if the submission has been forwarded by a UDSCP server, or clear if this is the first UDSCP server to deal with the submission (i.e., the submission came from a client).

QUEUE STATUS REQUEST (UDSCP_ QueueStatusReq): This packet requests the status of the UDSCP queue. The expected response is either an MCMP_Status packet or a

UDSCP QueueStatusResp packet.

The MCMP Header of the queue status request packet is:

Packet Type:	UDSCP _ Queue Status Req (h0003)
PacketSize:	0
ResourceID's:	None
Shunable:	No
ResourceReq:	No

QUEUE STATUS RESPONSE (UDSCP:QueueStatusResp): This packet is the response to a UDSCP_QueueStatusReq packet. It contains information about the UDSCP server's current UDSCP queue status. The MCMP Header is:

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PacketType: UDSCPQueueStatusResp (h0004)

PacketSize: 0

ResourceID's: None

Shuntable: No

5 ResourceReq: No

The Packet Body of this status response packet is:

QueueStatus,64

- Entries,4 \$\$ Total number of entries in the queue
- LowEntAge,4 \$\$ Age of the newest entry in the queue, in
10 seconds
- HighEntAge,4 \$\$ Age of the oldest entry in the queue
- AvgEntAge,4 \$\$ Age of the average queue entry
- HighPriEnt,4 \$\$ Number of high-priority entries in the queue
- LowPriEnt,4 \$\$ Number of low-priority entries in the queue
- 15 · FwdEnt,4 \$\$ Number of entries which have been forwarded
- ToFwdEnt,4 \$\$ Number of entries which must be forwarded
- ,32 \$\$ Reserved

The Metered Delivery and Billing Protocol (MDBP) controls access to pay-for content, including delivering credit to pay for the content, and collecting royalty information after the
20 content has been purchased.

MDBP Packet Types

The MDBP protocol works closely with the CMXP protocol. The CMXP protocol is used to deliver the content in encrypted form. The content is then decrypted when it is

unlocked by the MDBP libraries on the client machine. The content is unlocked when it is paid for with credit on the local machine. Credit can be replenished through the MDBP protocol.

When credit is replenished on the local machine, the royalty information is reported to the credit server, which then handles the appropriate distribution of profits.

5 In a standard credit-purchasing transaction, three packets are exchanged:

- An MDBP_CreditReq is sent from the client to the server
- The server responds with an MDBP_CreditTransfer
- The client sends an MDBP_PurchaseReport to the server

Before credit can be purchased by a user, that user must be registered with the credit
10 server.

The following is a list of the packet types used by the MDMP protocol at this time. The functionality of the MDBP protocol can be expanded in future by adding to this list of packet types.

	MDBP_CreditReq	= 2	\$\$ Request for additional credit
15	MDBP_CreditTransfer	= 3	\$\$ Response to MDBP_CreditReq
	MDBP_RegisterUser	= 4	\$\$ Register a user
	MDBP_RegisterUserResp	= 5	\$\$ Response to MDBP_RegisterUser
	MDBP_WriteUserData	= 6	\$\$ Write user data
	MDBP_ReadUserData	= 7	\$\$ Read user data
20	MDBP_ReadUserDataResp	= 8	\$\$ Response to MDBP_ReadUserData
	MDBP_PurchaseReport	= 9	\$\$ Purchasing/Royalty Report

The MDBP packet types are described in detail below.

REQUEST FOR ADDITIONAL CREDIT (MDBP_CreditReq): This packet requests additional credit from the server. The packet body contains the user's ID code, which is used to

access the user's data in the user database, as well as the amount of credit to be purchased. The user's data includes a billing method to use to pay for the credit. This packet must be encrypted. The expected response is either an MDBP_CreditResp or an MCMP_Status packet.

The MCMP Header of a credit request packet is:

5	PacketType:	MDBP_CreditReq (h0002)
	PacketSize:	22
	ResourceID's:	None
	Shutable:	No
	ResourceReq:	No

10 The Packet Body of a credit request packet is:

UserID,8	\$\$ User ID; B-byte integer value
Password,10	\$\$ User' 8 password
Credit, 4,r	\$\$ How much credit to purchase (in dollars)

CREDIT TRANSFER (MDBP_CreditTransfer): This packet is the response to an
 15 MDBP_CreditReq. It actually performs the transfer of credit from the server to the client. The packet body contains information on the credit transfer. This packet must be encrypted.

The MCMP Header of a credit transfer packet is:

20	PacketType:	MDBP_CreditReq thOo03)
	PacketSize:	20
	ResourceID's:	None
	Shutable:	No
	ResourceReq:	No

The Packet Body of a credit transfer packet is:

UserID,8	\$\$ The ID of the user who should be receiving this credit
----------	---

Credit, 4,r \$\$ The amount of credit purchased (in dollars)

Tserial,8 \$\$ A serial number used to track the transaction

USER REGISTRATION (MDBP_RegisterUser): This packet is used for the initial registration of a user with a credit server. It causes a new entry to be created in the user registration database. The packet body contains information about the user which will be written into the standard fields in the user's new record. The information can be read and modified at a later time through use of the MDBP_WriteUserData and MDBP_ReadUserData packets. This packet must be encrypted. The expected response to this packet is an MDBP_RegisterUserResp or MCMP_Status packet.

10 The MCMP Header of a user registration packet is:

PacketType: MDBP_RegisterUser (hO004)

PacketSize:

ResourceID's: None

Shuntable: No

15 ResourceReq: No

The Packet Body of a user registration packet is:

RegisterUser, 512

· Name,54 \$\$ Full name

· Company, 54 \$\$ Company name

20 · Address1,45 \$\$ Line 1 of the street address

· Address2,45 \$\$ Line 2 of the street address

· City, 20 \$\$ City name

· State,2 \$\$ 2-letter state abbreviation

· Pcode,16 \$\$ Postal code (zip code)

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- Country,30 \$\$ Country name
- Telephone,16 \$\$ Telephone number
- AX,16 \$\$ FAX number
- Email,100 \$\$ E-mail address
- 5 · CardNo,20 \$\$ Credit card number ('nnnn nnnn nnnn nnnn')
- CardExpDate,5 \$\$ Credit card expiration date ('mm/yy' or 'mm-yy')
- Password, 10 \$\$ Password
- ,79 \$\$ Reserved

10 USER REGISTRATION RESPONSE (MDBP_RegisterUserResp): This packet is the response to an MDBP_RegisterUser packet. It acknowledges the fact that the user has been registered, and returns the user's assigned ID code. The MCMP Header of this packet is:

	PacketType:	MDBP_RegisterUserResp (h0005)
	PacketSize:	8
15	ResourceID's:	None
	Shunable:	No
	ResourceReq:	No

The Packet Body is:

· userID,8 \$\$ user ID; 8-byte integer value

20 WRITE USER DATA (MDBP WriteUserData): This packet writes data to the user database. This uses a resource identifier to identify the element in the user registration database to write to. The packet body is the data to be written. This packet uses a special type of resource identifier, which is defined as follows:

type userid[,dbitem];length[:date,time]

Where:

type	Identifies the resource type; is always "mdbpuser"
userid	The ID of the user in question (in hexadecimal)
dbitem	Path to user database item to retrieve. If omitted, a tree-file is
5	resumed containing the entire user data tree for the specified user.
length	Portion of item to be returned.

Examples:

mdbpuser:000000000000003e4,\Catharon\RAdmin\Rights;*;03/13/1995,12:20:48

10 mdbpuser:00000000000000014;*

mdbpuser:000000000000002aff\XYZWidgt\WDBP\GroupMembership;256;
5/12/1996,01:00:30

The user database contains a system folder and a publishers folder. The system folder contains the data specified in the initial User Registration packet, and can be expanded to

15 contain additional data. The publishers folder contains a subfolder for each publisher, named based on the publisher's name, and the publisher's folder contain, in turn, publication folders, named based on the publication. The organization of data within a publication folder is specific to the publication.

The MCMP Header of the write user data packet is:

20	PacketType:	MDBP_WriteUserData (h0006)
	PacketSize:	Variable
	ResourceID's:	1 (The resource to write to)
	Shuntable:	No
	ResourceReq:	Yes

READ USER DATA (MDBP_ReadUserData): This packet reads data from the user database. This uses a resource identifier to identify the element in the user registration database to read from. The format of the resource identifier is the same as that for the resource identifier used in the MDBP_WriteUserData packet.

- 5 Multiple resource identifiers can be specified, causing each of the specified elements in the user registration database to be returned.

This packet is responded to with a series of packets (one for each request resource). These packets are either MDBP_ReadUserDataResp (if the resource was successfully read) or MCMP_Status (if there was an error reading the resource).

- 10 The MCMP Header of the read user data packet is:

PacketType: MDBP_ReadUserData (h0007)

PacketSize: 0

ResourceID's: 1 or more

Shuntable: No

- 15 ResourceReq: Yes

READ USER DATA RESPONSE (MDBP_ReadUserDataResp): This packet is the response to an MDBP_ReadUserData packet. It contains the content of the requested element of the user registration database. The body is the data that was read. The MCMP Header is:

PacketType: MDBP_ReadUserDataResp (h0008)

- 20 PacketSize: Variable

ResourceID's: None

Shuntable: No

ResourceReq: No

PURCHASING/ROYALTY REPORT (MDBP_PurchaseReport): One or more of

these packets is sent from the client to the server after the client has received a response to an MDBP_CreditReq packet, if the client has purchasing or royalty information to report.

The data area contains a generic royalty report header followed by a publication-specific royalty-report data area. In some cases, the royalty report header is sufficient to report the needed royalty information, so the data area is optional and does not have to be included. Any data following the royalty report header is assumed to be publication-specific data.

The MCMP Header of the royalty report packet is:

10	PacketType:	MDBP_PurchaseReport (h0009)
	PacketSize:	Variable
	ResourceID's:	None
	Shuntable:	No
	ResourceReq:	No

The Royalty Report Header is

15	RoyaltyReport,128	
	HeaderSize,2	\$\$ Size, in bytes, of royalty report header
	Publisher,45	\$\$ Name of publisher
	Publication,45	\$\$ Name of publication
	VolIssue,20	\$\$ Volume and/or issue number of publication, if applicable
20	Version, 4	\$\$ Version of publication, if applicable
	UserID,8	\$\$ ID of user who was reading this publication
	CreditSpent,4,r	\$\$ Credit spent, in dollars, on this publication

DPP Packet Types

The distributed processing protocol (DPP) is used to reduce the processing load created by a particular task by distributing it over multiple computers. The protocol is used to search for and locate idle systems and (in conjunction with the CMXP protocol) transmit the appropriate code modules to those systems so that they can assist with the task. When the task is complete, the protocol is used to gather the results from all of the "assisting" machines and collect them and compile them on the machine that initiated the task.

The functionality provided by this protocol should not be confused with the load distribution functionality provided by the main MCMP protocol. The MCMP protocol's load distribution works by distributing client requests over various machines in various locations.

10 The DPP protocol uses several machines working together to accomplish a single task, and is more suited to a local area network, and to processor intensive tasks, such as rendering of 3D images.

Each system involved in the distributed processing process must be configured with a list of those systems which can assist it with a task, as well as those systems which it can assist with tasks. This list can include entries with wildcards, to specify an entire network, such as 192.168.123.* for the entire 192.168.123. C-level network.

The purpose for this system configuration is to control who can utilize a system's processor. For example, a company might want to limit shared processing to systems within it's own internal network, for security reasons.

20 Systems can also be assigned priorities for access to a computer's processor. For example, a company may want all of it's computer to grant distributed processing requests from other computers on it's network in preference to other requests. However, if that company is affiliated with some other company, it might want to grant that other company access to it's computers for distributed processing purposes, provided that none of it's own

computers require processing assistance.

The following is a list of the packet types used by the DPP protocol at this time. The functionality of the DPP protocol can be expanded in future by adding to this list of packet types.

5	DPP_AssistReq	= 2	\$\$ Request for processing assistance
	DPP_AssistResp	= 3	\$\$ Response to DPP_AssistReq
	DPP_EndTaskReq	= 4	\$\$ Request to terminate processing assistance
	DPP_EndTaskNotify	= 5	\$\$ Notification of termination of assistance
	DPP_UpdateReq	= 6	\$\$ Request for update of task status
10	DPP_UpdateResp	= 7	\$\$ Response to UpdateReq

These packet types are described in detail below.

REQUEST FOR PROCESSING ASSISTANCE (DPP_AssistReq): This packet is sent by a system requiring processing assistance to another system to request processing assistance from that system. This packet contains all the information needed to initiate a distributed
 15 process, including the resource identifier for the initial code module to handle the process, so that the code module can be fetched via CMXP if necessary. The response to this packet is either a DPP_AssistResp packet (if the recipient system can assist) or an MCMP Status packet (if the recipient system can not assist).

Possible reasons for an MCMP_Status packet can include:

20 · Access Denied

The system to which the packet was sent was not allowed to assist with the request. This is a result of the system generating the request not being listed in the appropriate configuration file on the receiving system.

· Insufficient Free System Resources

There are not enough free system resources on the system receiving the request for that system to assist with the distributed process. In some cases, a system may be too busy to even return this status value.

Request Superceded

5 This indicates that the system had enough free processor time, but chose to assist a different system in preference to the one sending the request. The reason that Request Superceded is a separate status code from Access Denied is that "Access Denied" may generate an error if encountered by a program searching for systems to assist it (to notify the user of a possible
10 mis-configuration) while Request Superceded would simply indicate that the system is not available to assist with the task at that given time, and would therefore not generate an error.

Task-Specific Error

This is resumed by the code module that would handle the task. The
15 MCMP_Status packet will contain an additional task-specific error code indicating the specific error which occurred. Task specific errors might include an error indicating that the system is not capable of assisting with the task due to a hardware limitation.

20 The packet body of the assistance request packet consists of a 32-byte header, followed by a task-specific data area, which contains any information that the code module referenced in the Resource ID requires to assist in the processing of the task. This could, for example, include an image (if an image must be processed) or a description of a 3D environment to be rendered.

The task-specific data area also contains information indicating which portion of the task the system is to work on (for example, starting and ending lines in the image) as well as the frequency with which the assisting system is to update the initiating system with processed data.

5 The MCMP Header of the assistance request packet is:

PacketType:	DPP_AssistReq (h0002)
PacketSize:	32 + Size of task-specific data
ResourceID's:	One (The ID of the code module to handle the distributed process)
Shuntable:	No
ResourceReq:	No

10

The DPP_AssistReq Header is:

DPP_AssistReq Hdr,32	
ProcessID,2	\$\$ Process Identifier
,30	\$\$ Reserved

15

The elements of the DPP_AssistReq Header are described in detail below:

Process-ID: This is a 2-byte integer value that identifies the process. It is assigned by the system initiating the process, and is a unique identifier when combined with that system's IP address.

20 DPP_AssistResp: This packet is sent in response to a DPP_AssistReq to acknowledge that the system has begun assisting with the task. Because this is simply an acknowledgement message, there are no Resource ID's and there is no packet body. The MCMP Header is:

PacketType:	DPP_AssistResp (h0003)
PacketSize:	0

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ResourceID's: None

Shuntable: No

ResourceReq: No

DPP_EndTaskReq: This packet is sent to an assisting system to instruct that system to
 5 cease assisting with a task prematurely (before the task is complete). This would be used, for
 example, if the user on the initiating system were to click a "cancel" button and abort the task.

The MCMP Header is:

PacketType: DPP_EndTaskReq (h0004)

PacketSize: 16

10 ResourceID's: One (The ID of the code module to handle the
 distributed process)

Shuntable: No

ResourceReq: No

The **Packet Body** of the end task request header is:

15 DPP_EndTaskReq, 16

ProcessID, 2 \$\$ ID of process to terminate

, 14 \$\$ Reserved

DPP_EndTaskNotify: This packet is sent by an assisting system to notify the initiating
 system that it will no longer be assisting with a task. This is used both by itself, and as an
 20 acknowledgement to a DPP_EndTaskReq packet. This would be sent if, for example, the
 assisting system was to become too busy to continue to assist with the task, or if the assisting
 system was to be instructed by the initiating system to abort the task. This packet can also be
 used to notify an initiating system of a completed task. The MCMP Header is:

PacketType: DPP_EndTaskNotify (h0005)

84

PacketSize: 16

ResourceID's: One (The ID of the code module to handle the distributed process)

Shuntable: No

5 ResourceReq: No

The Packet Body of the end task notification packet is:

DPP_EndTaskResp, 16

ProcessID, 2 \$\$ ID of process to terminate

Tstatus, 1 \$\$ Task status; 1=Complete, 0=Incomplete (Aborted)

10 , 13 \$\$ Reserved

DPP_UpdateReq: This packet is sent by the initiating system to instruct the assisting system to transmit processed data (a DDP_UpdateResp packet). For example, if an image was being processed, this would cause the assisting system to respond with the data making up the portion of the image that it has processed so far. The use of this packet type depends on the task. Some tasks will not use this packet at all, and will instead automatically generate DPP_UpdateResp packets at various intervals, and when the task is complete. The MCMP Header is:

PacketType: DPP_UpdateReq (h0006)

PacketSize: 1 6

20 ResourceID's: One (The ID of the code module to handle the distributed process)

Shuntable: No

ResourceReq: No

The Packet Body of the update request packet is:

85

DPP_EndTaskResp,16

ProcessID,2 \$\$ ID of process for which to return processed data

,14 \$\$ Reserved

DPP_UpdateResp: This packet is sent from an assisting system to an initiating system.

- 5 It contains the data that has been processed so far as part of the task in question. For example, if an image is being processed, this packet would contain the portion of the image that had already been processed. Note that the data sent in these packets is not cumulative. That is, if two packets are sent in succession, the second contains only data not included in the first.

These packets are often sent in response to DPP_UpdateReq packets, although they
10 can also be sent automatically by the program handling the task assistance, both during the task and upon task completion.

The packet body consists of a header, followed by task-specific data. All data not part of the header is assumed to be task-specific data.

The MCMP Header of the update response packet is:

15 PacketType: DPP_UpdateResp (h0007)

 PacketSize: 16 + Size of task-specific data

 ResourceID's: One (The ID of the code module to handle the distributed process)

 Shuntable: No

20 ResourceReq: No

DPP_UpdateResp Header is:

DPP_UpdateResp,16

HeaderSize,2 \$\$ Size, in bytes, of DPP_UpdateResp header

ProcessID,2 \$\$ ID of process for which to return processed

86

data

,12

\$\$ Reserved

The term "code module" is used herein to denote a self-standing portion of an applications program dedicated to the performance of a specific operation of the applications program. For example, in a painting program, one code module may control the drawing of a line, while another code module implements the application of color and yet another code module is used for generating a geometrical figure such as a circle. These code modules are independent in that at least some of them are not required for executing any particular operation. Sometimes two or more modules are required to produce a particular result. However, in no case are all modules required.

The term "machine-executable" as used herein refers to code modules which are program modules, capable of controlling computer operations and changing the state of the arithmetic logic circuits of a general purpose digital computer, thereby changing the functionality of the general purpose digital computer. Thus, "machine-executable code modules" do not include data files and other passive electronically encoded information.

The term "applications program" as used herein refers to any executable collection of computer code other than operating systems and other underlying programming for controlling basic machine functions. Thus, the Modularized Code Master Protocol, including its subprotocols, is an applications program which is itself modularized and transmittable in code modules over a network. For example, at least some subprotocols will not exist on some secondary servers. Should such a subprotocol be required for a secondary server to compete a task or process a user's request, then that required subprotocol may be transmitted over the network from the primary server to the secondary server.

Subprotocols are handled by including a subprotocol identifier in the MCMP Header

attached to each MCMP packet. On an MCMP server, the circuits for handling the subprotocols may be plug-in modules which are handled in real-time by the CMXP protocol. When an incoming packet is received, the appropriate subprotocol handler is called. The subprotocol handler can then process the packet in whatever way is required. A protocol handler becomes involved in the load distribution process because the MCMP server has no way of knowing what format the resources are in, how to transfer them between servers, or what the caching rules are. The subprotocol handler must deal with accessing, transfer, and caching of the protocol-specific resources. The subprotocol handlers are called periodically during the MCMP server's main processing loop, allowing it to perform various maintenance tasks. Alternatively, the subprotocol handler could be called from a loop running in a separate thread.

The handler for a specific subprotocol may request that the MCMP server flag a socket as being in a Proprietary Dialog Mode (PDM). On a PDM socket, all incoming data is passed directly to the subprotocol handler without being processed by the MCMP server. When a socket is returned to normal operation from the PDM operation, the subprotocol handler must pass any "extra" unprocessed data to the MCMP server, since it may have read a portion of one or more MCMP packets.

The term "primary server" or "source server" is used herein to denote the authoritative source for the resources relating to a particular application. For example, the primary server for the TenCORE Net Demo would be the server where the latest version of the demo was always posted.

The term "secondary server" as used herein denotes a server that receives service-handoffs from a primary server. A secondary server usually mirrors the content of the primary server for which it is secondary. For example, a secondary server for the TenCORE

Net Demo would be a server that could take over servicing clients if the primary server became too busy. A secondary server does not necessarily contain mirrors of the resources for which it is secondary server, inasmuch as the secondary server can request these resources from the primary server as needed.

5 A single machine is can be both a primary server and a secondary server. For example, a machine could be primary server for the TenCORE Net Demo, and secondary server for the Country Closet Clothing Catalog.

A single machine can function as primary server for multiple applications, and can function as secondary server for multiple applications.

10 The word "resource" is used herein to denote any block of data that can be used by a server or client. A resource can be a file, a code module, a portion of a file, a code module, a portion of a code module, a file directory, a code module directory, or any related piece of information, including the CMXP Prohibited List. The term "resource" is also used to refer to hardware and system resources, such as processor time and memory.

15 The term "tree-file" refers to a Catharon Tree-Structure Nameset File. A tree-file contains a series of named sets of records, which are grouped and nested into a tree-like structure (similar to an operating system's file system). In tree files, names beginning with a percent sign "%" are reserved for internal use. Any other names may be used by whatever application is maintaining the tree-file. Currently, only one percent-sign name has been
20 assigned. It is "%System" and it contains general information about the file, including (optionally) the name of the application that created the file, the user under who's network account the file was last edited, the date and time the file was last edited, the location of various resources in the file, the location of the default folder (if none specified), and the file's associated information.

As related hereinabove, TenCORE is an interpreted language which utilizes pseudocode. Interpreter programs suitable for use with the TenCORE programming language as modified in accordance with the above descriptions are in common use today.

5 A description of the TenCORE programming language is set forth below. The basic characteristics of the language are discussed first, then the treatment of variables. Finally, an exposition is made of all the important commands used in the language. From this information, as well as the foregoing description, one of ordinary skill in the art can generate a modular programming language suitable for use in the invention.

TenCORE Language Basics

The TenCORE Language Authoring System is a complete programming environment specially enhanced for implementing computer-based training. Its editors aid in the creation of source code, images, fonts, screen displays and data manipulation. The language has complete facilities for display creation, response input and analysis, and data manipulation within a structured programming environment.

Command Syntax

The primary building block of the language is the **command**. TenCORE contains about 175 commands mnemonically named for the functions they perform. Most commands are followed by a **tag** often with keywords that further define the specific function desired. A command and tag taken together is called a **statement**. As in any language, there are rules that determine the syntax of a tag and how a sequence of statements interact to perform a specific task.

The TenCORE language is a fixed field language. In the simplest form, the syntax has the form:

command tag

The *command* field contains the name of a command of up to 8 characters long. The *tag* field begins at character position 9 (there is a tab stop here in the source editor) and can be up to 119 characters in length on the remainder of the line. For many commands, the tag can be continued for several lines by tabbing over (leaving blank) the command field on the following lines. Some typical lines of code look like this:

```
at      5:10
color   yellow
write   Welcome to Basic Sign Language
```

Today's lesson consists of...

Each statement begins with a command and is followed by a tag. In the first line, the **at** command causes the cursor to be positioned on the fifth line and tenth character position of the display. The second **color** command selects yellow to be used for following graphics and text.

5 The last **write command** puts text on the display at the position and color previously specified. The **write** statement's tag continues over several lines by tabbing over succeeding command fields.

Selective Form

Many commands have a selective form:

10 command **SELECTOR**: negTAG, zeroTAG, oneTAG, ... nTAG

The *SELECTOR* is an expression consisting of variables, constants or calculations that is evaluated and used to select a specific tag from the list. The tags are usually separated by semicolons although other separators are available. The *nTAG* case is selected when *SELECTOR* evaluates to *n* or greater. A blank entry in the list (*..*) can be used to skip execution of the

15 command for a specific case. If *day* is defined as an integer variable programmed to hold a particular day of the week, then the following statements would display that day on the screen

```

at          5:10
write       Today is
writet     day;;; Monday; Tuesday; Wednesday; Thursday;
20           Friday; Saturday; Sunday

```

Since TenCORE defines logical *true* to be the value -1 (or any negative value) and *false* to be 0 (or any positive value), any two tag selective acts as a true or false decision:

command **SELECTOR**: trueTAG; falseTAG

Conditional Form

Some commands (especially the judging commands) have only a *CONDITION* as the tag that is used to determine if the command executes or not. The condition is any expression that logically evaluates to *true* (-1) or *false* (0).

5 command *CONDITION*

For example, if you wanted to accept misspellings after a student's third attempt at matching a response, you could use a conditional expression based on the system variable *ztries* which holds the number of previous judging attempts:

```
okspell ztries > 3
```

10 answer Mississippi

Embedding

Many text handling commands allow the embedding of further commands in the body of the text.

command TEXT «command.tag» TEXT

15 The symbols « and » are the embedding symbols accessed by the [ALT][.] and [ALT][] keys. Frequently, the embedded command name can be abbreviated to the first letter or two to save space: e g., the abbreviated form of the embedded **show** command is simply **s**. Embedding is frequently used for display of variables and the control of plotting attributes within text statements thereby efficiently coding for an entire display:

20 write «color,red»Your score «color,white» is «show,score»%.

 The «c,green»class average «c,white» is «s,average»%.

Comments. Spacing and Continued Commands

An asterisk (*) at the beginning of a line marks the entire line as a comment that is removed by the compiler and has no effect on execution. A comment can be placed on any line of

code by placing it after double dollar signs \$\$: the compiler removes the comment and it does not affect the execution of the code:

```
calc      temp ← temp*9/5 + 32      $$ convert centigrade to Fahrenheit
```

Normally, trailing spaces on a tag are removed by the compiler and do not affect

5 execution. This is also true when double dollar \$\$ comment signs are used: the compiler removes the comment and any spaces back to the real tag. For some text commands, you may actually want the trailing spaces and can direct the compiler to maintain them by using an on-line comment with triple dollar signs \$\$\$. The following example would display something like

Welcome Bob:

```
10 write    Welcome $$$      maintain single trailing space
showa      name
```

Most commands with non-selective tags can be repeated again without the need for typing in the command field again. "Space" can also be added between most lines of code to make the coding read well:

```
15 *        This section of code initializes parameters.

calc      frame ← 2045          $$ starting frame number

          file ← 'bangs'        $$ use the explosion library

          block ← 'mega'        $$ use the big explosion

          type ← 'nameset'      $$ these are nameset files

20 attach  file;type            $$ attach the file
```

Units

A sequence of TenCORE statements makes up a functional entity called a *unit* analogous to a procedure or subroutine in other languages.

Commands can be grouped into units in any way that makes sense. Simple "page turning" lessons consist of multiple frames of material: each could be a unit. A complex graphic that is

25

used several places in a lesson can be put once into a single unit which is then referenced at each point it is needed. A simulation can have each functional part in its own unit.

Each unit must have a unique name of up to 8 characters in length starting with a letter. Punctuation, special symbols and the two system reserved names **x** and **q** are not allowed.

5 **Referencing Units**

If you want to reference a unit in the same lesson, you simply state the unit's name:

```
do            clock            $$ call unit clock to start timing going
```

If you want to access a unit in a lesson different from the one currently executing, then you must give both the lesson and unit names:

```
10 do            maps,illinois    $$ show the map of Illinois
```

Finally, you may not want to explicitly state the unit or lesson names but rather refer to names that have been calculated into variables. This is done by *embedding* the variables where the explicit names would normally appear. Embedding consists of surrounding the variables with the « and » symbols. For example, say that all the lesson and unit names in a project have been put
15 into the 8-byte arrays *lessons* and *units*. then any unit can be accessed by setting the indices to point to the desired unit:

```
do            «lessons(i)», «units(j)»
```

Generic Unit Names

System keyword names exist to provide generic branch destinations to main units in the
20 current lesson or back to the system. For example, **=next** and **=back** can be used for the unit name when **jumping** to the next or previous main unit in the current lesson; **=exit** can be used to exit the current lesson back to DOS, the editor or the system Activity Manager. A descriptive list of the nine generic unit names along with examples of their use is found with the **jump** write-up.

Unit Terminology

Units can play a number of different roles during execution depending on how they are used. Units may correspond to major displays and interactions that a user experiences: the "pages" of the lesson. On the other hand, a unit may simply be a subroutine called by one of these major units to perform a sub-task. The following terms are used to describe various functional units.

main unit

A main unit is the first unit executed in a lesson and any other unit reached by a **jump** type branch. It normally corresponds to one "page" or user situation in the lesson. It is the starting point for all user interaction. When the end of the main unit is reached in execution, the system waits for a key press or other interaction to occur to branch the user to another main unit.

Branching to a new main unit normally:

- erases the screen
- re-initializes all plotting parameters
- resets branches to their lesson defaults
- clears all pointer areas
- establishes a new main reference point in the lesson

current unit

The **current** unit is the unit currently executing. It may be the main unit or a subroutine unit called from the main unit by a **do** or **flow** command.

done unit

A **done** or called unit is used to describe a unit executed as a subroutine. When the end of a done unit is reached, control returns to the command following the calling command in the invoking unit or to the waiting state from where a **flow** branch was triggered.

base unit

The **base** unit is the main unit at the time a branch occurred that was modified with the **base** keyword. It can be used to set up a common help sequence that can automatically return to whatever main unit called it. Return to the base unit occurs through a branch using the **=base** generic name.

startup unit

The **startup** unit is the first unit executed in your lesson either from DOS or a router such as the system Activity Manager. It is usually the first physical unit in the lesson file and should contain a **startup** command if the unit is to be directly entered from DOS.

restart unit

A **restart** unit is placed in the lesson flow where return from an interruption in the learning session can occur. It would generally have a **restart** command in it and should have a display that can re-orient the student after the interruption. The system Activity Manager would branch a user to one of these units if the "continue last lesson" option is chosen upon student signon.

Control Blocks

Control blocks offer a means to expand control of major events such as starting or quitting a lesson or in going from one main unit to another. Coding in a lesson's control blocks is automatically executed at these major events regardless of the specific starting, ending or main unit involved. This is a convenient way to ensure that necessary initializations or cleanups are done. Control blocks are created in the editor on the block directory page. Besides the following, some additional control blocks are discussed in the **Updates** chapter.

+initial

The code in a **+initial** control block is executed each time an outside **jump** type branch is made to the lesson: e.g., starting the lesson from **DOS**, executing the lesson from the editor, jumping to the lesson from another lesson or from the Activity Manager. It can be used to load
5 fonts, set plotting conditions, initialize data keeping, etc. regardless of where entry to a lesson occurs.

+main

A **+main** control block is executed each time a new main unit is entered: it is used to perform operations common to the beginning of all the main units in a lesson. For example, it can
10 be used for: displaying a lesson-wide background image and flow bar, saving restart information, or displaying debugging information during lesson editing such as the current main unit name.

+exit

A **+exit** control block is executed whenever control leaves the current lesson as during a **jump** to a different lesson or when quitting to **DOS** or to the calling program that started the
15 current lesson running. It can be used, for example, to collect end-of-lesson summary information or to turn off any devices that were turned on for the lesson.

+editor

A **+editor** control block is executed each time you go to edit the file. It can be used, for example, to load fonts for text editing.

20 **Screen Resolution**

A wide range of **PC** display hardware is supported from the original **CGA** and **EGA** adapters to **MCGA**, **VGA** and Enhanced **VGA** adapters. Each of these includes an increasing collection of graphic and text screen resolutions and color capabilities. TenCORE courseware is typically created using a specific screen resolution and color range that is supported on the target

population of run-time machines for your courseware: often the lowest common denominator is used. The **screen** command selects these parameters and is usually placed in the **+initial** control block of a lesson.

Graphic Coordinates

- 5 A particular screen pixel is addressed by **x** and **y** graphic coordinates with 0,0 specifying the lower left corner of the screen:

```
dot      100,      200          $$ write the pixel at x=100, y=200
at        320,      240          $$ at the center of the vga screen
circle,  75,fill                $$ draw a filled circle of radius 75
```

- 10 Most display commands update the system variables **zx** and **zy** as part of their operation and thereby define the current screen location.

Character Coordinates

Text can be more conveniently addressed by character coordinates that specify a line number and character position that are separated by a colon to distinguish them from graphic

15 coordinates:

```
at          5:15          $$ line 5 character 15
write      Text on line 5...
```

Defaults

- 20 Graphics and text commands display using the current settings for numerous attributes such as: the foreground and background colors, the plotting mode, text size and drop shadowing, etc. These attributes can be set just prior to using them:

```
color      yellow          $$ the following in yellow
mode       write           $$ overstrike plotting mode
25 text     shadow; on      $$ drop shadowing on text
```

99

```

text      size; 2          $$ size two fonts
at        5:10            $$ at line 5, character 1
write     A cross section of the sun...

```

Attributes have initial default values that are set by the system when executing an **initial** or **screen** command as at the start of a lesson: e.g., the system default foreground color is white and the text size is 1. Attributes are automatically returned to their default values at the start of each main unit or they can be forced as a group to their default values at any time by use of the statement **status restore: default**. Upon jumping to a new main unit after executing the above example code, size 1 text and color white would be put back in operation. See the **initial** command for a list of the display attributes and their standard default values.

To give a common "feel" to a lesson, it is convenient to set the attribute values to your default values at the start of all units in the lesson. That way, if you later change your mind about using, say, the gothic font throughout a lesson, you can merely change the font default value to something else and have it apply to the entire lesson. The **status save: default** statement is used to reset the attribute defaults to their current values:

```

color     yellow
text      spacing; variable
text      shadow, on
text      margin; wordwrap
status    save; default      $$ the above are now lesson defaults

```

Lesson defaults are usually set in the **+initial** control block of a lesson.

Variables

Author-Defined Variables

TenCORE supports both local and global variables.

100

Local variables are defined in a specific unit and are available only to that unit. When a unit is exited, either by reaching the end of the unit or by branching to a new main unit, the values of its local variables are lost.

Global variables are available throughout the lesson in which they are defined and retain their values for the entire program. With the help of the TenCORE Activity Manager or a similar program, global variables can even be made to retain their values across TenCORE sessions.

Local Variables

Local variables are created by defining them within a source unit, between a **define local** and a **define end** statement.

```
10  define    local
    height,2    $$ defines the 2-byte integer variable height
    length,4,r  $$ defines the 4-byte real variable length
    define    end
```

Variables defined in this way are known only to the unit in which the definition occurs, and the values assigned to these variables are lost when the unit is exited via any command which goes to a new main unit.

Local variables are usually used for temporary information which is not needed outside the current unit, such as loop indexes.

Global Variables

20 A special block, called the **defines** block, is normally used to hold global variable definitions. Within the **defines** block, variables are defined by inserting lines of this form:

name,size[,type]

as in:

defines

height,2 \$\$ defines the 2-byte integer variable **height**

length,4,r \$\$ defines the 4-byte real variable **length**

Variables defined within a **defines** block are global variables. They are available in every unit within the file, and are normally used to store information which is needed in several places, such as the user's name or status within the program.

Global variables for every lesson are stored from the beginning of a single memory area reserved for global variable storage. This means that if a program extends over two or more source files, it is important that all source files use the same defines and/or coordinate their shared use of this area. This subject is treated in more depth in the Physical Allocation of Variables chapter.

Local Definition of Global Variables

Similar to local variables, global variables can be defined between a **define global** and a **define end** statement.

```
15  define    global
    height,2
    length,4,r
    define    end
```

Variables defined between **define global** and **define end** use the global variable storage area, but are known only within the unit in which the definition occurs.

The **define global** command should be used only for isolated test units and a few special purpose utilities. Used without an understanding of how space for global variables is allocated, the **define global** command can lead to conflicting definitions of variables and unpredictable program behavior. For more information, see the Physical Allocation of Variables chapter.

Precedence of Variable Names

A local variable can be given the same name as an existing global variable: in this case, the local variable supercedes the global variable.

globals (defines block)

```
5  user,20
   screen,5
```

```
define local
user,4,r
```

```
10 define end
```

Here "user" has been defined as both a global and a local variable. Within unit **screen5**, the global variable "user" cannot be accessed. Any time that "user" appears in unit **screen5**, it refers to the local variable.

Variable Names

15 Variable names can be one to eight characters long. Any of the following may be used in variable names:

- letters (including those in the extended character set, such as Å and Ö)
- numerals
- period (.), underline (_), caret (^) and tilde (~)
- 20 • extended ASCII characters

The first character of a variable name may not be a numeral or a period. Some samples of valid variables names are:

```
username
Lesson
25 xLOCAT
```

x.loc

last_x

■list

root

5 Invalid variable names include:

2student may not start with a numeral

useraddress name longer than 8 characters

unit'n punctuation not allowed

Case is significant: the variable "a" is different from the variable "A" and the variable

10 "alpha" is different from the variables "Alpha" and "ALPHA".

Spacing around the elements of a variable definition is not significant. Most authors apply one of two different styles in defining variables

define local

width,2

15 height,2

area,2

length,2

mass,4,r

define end

20 In the style above, the length and type of each variable are written immediately after the variable name. Another common style is the following:

define local

width ,2

height ,2

25 area ,2

length ,2

mass ,4,r

define end

In this style, the lengths of all the definitions are aligned in a tabular format

These styles are functionally equivalent.

Variable Types

Any of the three types can be defined globally or locally. Variables in TenCORE are not "strongly typed", i.e. a variable defined as one type can often be used in operations primarily intended for another type of variable.

Integer Variables

Integer variables store positive and negative whole numbers. Integer variables are defined as follows:

```
a, 1
x, 2
line, 3
temp, 4
total, 8
```

Where the normal form is *name.size*. The size of an integer variable can be 1, 2, 3, 4, or 8 bytes. The size determines the range of values that the variable can store.

size	Range
1	-128 to 127
2	-32768 to 32767
3	-8,388,608 to 8,388,607
4	-2,147,483,648 to 2,147,483,647
8	$-9 \cdot 10^{18}$ to $9 \cdot 10^{18}$

Integer variables are significant for all values within their range: no rounding errors occur from addition, subtraction, or integer multiplication of integer values. However, rounding is performed when real values are assigned to integer variables and when integer division is performed.

Integer-type variables optionally take the *type* modifier **integer**, which can be abbreviated as **i**:

x,2,i

line,3,integer

5

TenCORE stores integer values in natural (high-byte to low-byte) order. (Many MS-DOS programs store integer values in low-byte to high-byte order.)

Real Variables

For storing non-integer numeric values, TenCORE provides *real* variables, which are defined as follows:

10

force,8,real

area,4,r

Where the normal form is *name.size.real*. Real variables can be either 4 or 8 bytes long, and the tag **real** or its abbreviation **r** must follow the size specification when the variable is

15 defined

The size of a real variable determines the range of values that the variable can store and the *precision*, measured in *significant digits*, with which the variable can store the value.

Size	Range	Significant Digits
4	$10^{\pm 25}$	6
8	$10^{\pm 25}$	15

Eight-byte real variables should be used whenever storage space is not at a premium. If 4-byte real variables must be used, they should be compared only to other 4-byte real variables.

20 Comparisons of the form **if length = 1.1** can give unexpected results due to the limited precision of 4-byte real variables.

Real variables are stored in IEEE format. As in the case of integer variables, the bytes are stored in natural (high-to-low) order rather than the reverse order used by some programs.

A variable declared with no size and no type is created as a 4-byte real variable.

Non-Numeric Buffer Variables

For holding text or other information, non-numeric variables can be defined with any size from 1 byte to 32767 bytes (provided that enough variable space is available), as in:

```
5  username,20
    unitname,8
    italics, 2052
```

The general format is *name,size*. Non-numeric variables are most often used to store text, but they can also be used to store any other information requiring a buffer.

10 There is no difference between the definition of a non-numeric variable with a length of 1, 2, 3, 4 or 8 bytes and the definition of an integer variable of the same size. Only the context in which the variable is used indicates whether the variable holds integer or non-numeric data.

In TenCORE command syntax, non-numeric variables are referred to as "buffers".

Arrays

15 The variable types described so far are all *scalar*, meaning that each variable holds only one value. TenCORE also supports *array* variables. An array is a series of variables of the same size and type, all referred to by the same name, using an *index* to specify individual elements of the array. An array index is simply a number in parentheses which appears immediately after the name of the array.

```
20  average(100),4,real    $$ array of one-hundred 4-byte reals
    count(5),2,i          $$ array of five 2-byte integers
    bignum(20),8          $$ array of twenty 8-byte integers
    table(10),256         $$ array of ten 256-byte non-numeric variables
```

The definition of an array variable looks like the definition of a scalar variable, except that the variable name is followed by a number in parentheses which specifies the number of elements (values) the array should hold. The general form for defining an array is:

name(elements),size, type

5 Arrays can then be referenced in TenCORE code as in:

```
calc      count(3) ← 10
datain    1,table(index),1
```

Brackets are synonymous with parentheses, permitting the following alternative notation.

```
calc      count[3] ← 10
0  datain  1,table[index],1
```

TenCORE supports only one-dimensional arrays; arrays of two or more dimensions can be simulated using functions

System-Defined Variables

TenCORE provides a number of system-defined variables which store information about
5 the current state of the program. These system-defined variables (usually shortened to system variables) are simply names which TenCORE recognizes as representing numbers or other variable information.

System variables provide information which is frequently needed or which might be tedious or impossible for the author to maintain in author-defined variables.

10 For instance, the system variable **ztries** can be used to refer to the number of times the user has entered a response to the currently active arrow structure:

```
if      ztries  > 3
.       write   The correct answer is: green
endif
```

This example displays the correct response to a question if the user has already tried to answer more than three times.

System variables all begin with the letter "z". This makes them easier to recognize. As a matter of good programming style, author-defined variables should therefore avoid names which begin with "z". It is possible to create an author-defined variable with the same name as a system variable. In this case, the author-defined variable has precedence and the value of the system-defined variable becomes unavailable

The following are examples of some other system variables.

- **zreturn** is set by many commands to indicate the success or failure of the command. A negative value of **zreturn** indicates success, while various non-negative values indicate different reasons for failure of the command. **zreturn** is a one-byte integer reflecting *command status*.
- **zcolor** is set to the value of the current foreground plotting color. It is a two-byte integer relating to *display control*.
- **zmainu** contains the name of the current main unit. It is an eight-byte variable relating to branching.

Values cannot be directly assigned to system variables. However, some system variables are affected by an associated command; for instance, **zcolor** indicates the currently selected foreground color and is therefore affected by the **color** command. Executing **color white+** sets **zcolor** to 15, the value corresponding to bright white.

A comprehensive list of system variables organized according to category follows. In addition, many command descriptions refer the reader to system variables affected by the command.

System Variables

	zareacnt	2(int)	Number of areas currently defined
	zareahl	2(int)	Area ID of currently highlighted area (0 if no area highlighted)
	zargs	1(int)	Number of non-null arguments actually received by either a -receive-or by
5			the return argument list of a -do
	zargsin	1(int)	Number of arguments sent by -do-, jump-, or -jumpop
	zargsout	1(int)	Number of arguments the invoking unit expects returned
	zaspectx	2(int)	x-aspect ratio correction factor
	zaspecty	2(int)	y-aspect ratio correction factor
0	zauthsys	1(int)	Indicates the TenCORE executor type:
			-1 = LAS author executor (TCAUTHOR.EXE)
			0 = student executor (TCRUN.EXE)
			1 = Producer executor (TPR.EXE)
	zbinary	1(int)	Type of file from which "zlesson" was loaded
15			-1 = binary; 0 = LAS source; 1 = Producer source
	zcharb	2(int)	Offset of standard size 1 font baseline
	zcharh	2(int)	Height in dots of standard font or charset
	zcharw	2(int)	Width in dots of standard font or charset Note: all text positioning is
			based on the standard font (zcharw, zcharh, zcharb), not the current font.
20	zclipx1	2(int)	X-coord of lower left corner of clipping area
	zclipx2	2(int)	X-coord of upper right corner of clipping area
	zclipy1	2(int)	Y-coord of lower left corner of clipping area
	zclipy2	2(int)	Y-coord of upper right corner of clipping area
	zclock	4(int)	Value of the system clock, accurate to ~55ms

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	zcolor	2(int) Foreground color set with -color
	zcolore	2(int) Erasure color set with -colore
	zcolorg	2(int) Background color set with -colorg
	zddisk	1(int) DOS default drive: 1=A:, 2=B:, 3=C:
5	zdisk	1(int) Method of searching for data files: Values same as "zedisk"
	zdisks	4(bits)Bitmap of drives TenCORE can access, set in DOS by SET CDISKS=
	zdisplay	1(int) Current active display number (dual screen driver only)
	zdispX	2(int)X-size of current window
	zdispy	2(int)Y-size of current window
10	zdolevel	2(int) Current level of do type command stack (do, library, flow do, flow library)
	zdomcnt	2(int) Number of existing domains
	zdomname	8(alpha)Name of current domain
	zdompar	8(alpha)Name of parent domain
15	zdoserr	1(int) DOS disk error code Set only when "zreturn" = 0, indicating a disk error: 0 disk is write-protected 2 drive not ready (door open or bad drive) 4 CRC error (error detected in data) 6 seek error (bad drive or diskette)
20		7 unknown media type (unrecognized diskette) 8 sector not found (bad drive or diskette) 12 general failure (bad drive or diskette)
	zdosver	4(alpha) DOS version number in the format "X.XX"
	zedisk	1(int) Method of searching for source/binary files:

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-1 = search all drives; 0 = search only "zddisk"

-2 = search only system pseudo-drive

1, 2, 3,... = search only drive A., B., C.

zedoserr 8(int) DOS extended error code, set when "zreturn" = 0. Valid only when

5 running under DOS 3.0 or higher. The format is:

2 bytes error code

1 byte error class

1 byte actions

1 byte locus

10 The remaining three bytes are reserved.

zenable 4(bits) -enable- flags

This variable is a set of bits numbered 1 to 32. Certain its correspond to -enable- commands as follows

1 enable absolute 9 (reserved)

15 2 enable pointer 10 (reserved)

3 enable mode 11 (reserved)

4 enable cursor 12 enable break

5 enable ptrup 13 enable arrow

6 enable font 14 (reserved)

20 7 enable area 15 enable fillbreak

8 (reserved) (bits 14-32 reserved)

Use the bit() function to test "zenable". For instance, bit(zenable,2) is -1 if the pointer is enabled and 0 if not

zenvlen 4(int) Length in bytes of DOS environment buffer

	zenvloc	4(int) Absolute memory location of DOS environment buffer
	zerrcode	2(int) "error code" value from "zedoserr"
	zerrlevl	2(int) DOS variable "errorlevel" as return from last exec file.- command
	zerrorl	8(alpha)Lesson name of unit to execute if an execution error occurs, set by -error
5	zerroru	8(alpha)Unit name of unit to execute on execution error
	zexitbin	1(int) Type of file from which =exit branch will be loaded: -1 = binary; 0 = source; 1 = tpr
	zexitl	8(alpha) Lesson name to branch to on -jump =exit
	zexitu	8(alpha)Unit name to branch to on -jump =exit
10	zfcrcs	4(int) Number of contiguous free records in the attached nameset type file
	zfdisk	1(int) Disk on which the attached file resides. 1 = drive A., 2 = drive B., etc. -2 = system path
	zflowcnt	2(int) Number of flow branches currently defined
15	zfname	8(alpha)Name of the attached file. 0 if none attached
	zfnames	2(int) Total number of names in the attached file; has no meaning for dataset files
	zfontb	2(int) Offset of current font baseline
	zfontf	4 (bits)For font groups, specifies which of the attributes were fit correctly and which were synthesized. Bits defined as follows: 6 = Bold attribute matches request 7 = Italic attribute matches request 8 = Size attribute matches request 16 = Narrow attribute matches request 22 = Bold Synthesized
20		

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23 = Italic Synthesized

24 = Size Synthesized

For the bits above that are synthesizable, the attribute may not match the request but also may not be synthesized; for example, if the font group only has bolded items, and the current attributes specify non-bolded, then bits 6 and 22 will both be off

zfonth 2 (int) Height in dots of currently active font

zfontret 1 (int) Information on how closely the selected font fits the requested parameters. All values available for font groups, For fonts, values -1, 2 and 3 are possible. Set by -font-, -text-, status restore-.

-2 = partial match, some synthesis required

-1 = exact match

= partial match, some non-synthesizable attributes could not be matched

1 = no suitable match found; base font is in effect

2 = base font not available; standard font is in effect

3 = standard font not available; charsets are in effect

zfontw 2(int) Width in dots of currently active font

zforce 2(bits) force- flags

This variable is a set of bits numbered 1 to 16. Certain bits correspond to -force- commands as follows:

1 force cursor lock-zinfo 8(int) Associated information bytes for the selected name in the attached file; has no meaning for dataset files

2 force number lock-

3 force extended-

4 force charset-

(bits 5-16 unused)

Use the bit() function to test "zforce". For instance, bit(zforce,1) is -1 if -force cursor lock- is in effect and 0 if not

- 5 **zfreccs** 4(int) Total number of data records in the attached file
- zfrombin** 1(int) Type of file from which "zfroml" was loaded:
-1 = binary; 0 = source; 1 = tpr
- zfromd** 1(int) Drive from which "zfroml" was loaded. Same values as zldisk
- zfrom** 8(alpha) Lesson name of unit which invoked current unit via -do-, -library-, or
10 main-unit branch
- zfromlin** 2(int) Line number of command in "zfromu" which which invoked the current unit
- zfromu** 8(alpha) Unit name of unit which invoked current unit
- zfreccs** 4(int) Total number of data records in the attached file
- 15 **zftype** 8(alpha) Type of the attached file; 0 if none attached; file types: source, tpr, dataset, nameset, binary, roster, course, studata, and group
- zfunames** 2(int) Number of names used in the attached file
- zfuerecs** 4(int) Number of records used in the attached file; has no meaning for dataset files
- 20 **zfter** 4(alpha) TenCORE version which created the attached nameset as "X.XX"
- zhcolor** 2(int) Hardware color set set with -color
- zhcolore** 2(int) Hardware erasure color set with -colore
- zhcolorg** 2(int) Hardware background color set with -colorg
- zhdisp** 2(int) Physical x-size of current screen type

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zinfo 8(int) Associated information bytes for the selected name in the attached file;
has no meaning for dataset files

zinput 2(int) Keypress value of last key processed

0 no input

5 1- 255 standard or extended character

> 255 non-character keypress

"zinput" contains 2-byte keypress values. To determine if "zinput" contains a particular value, one of the following forms is required:

zinput=%"character" zinput=%alt"character"

10 zinput=%ctl"character" zinput=%altctl"character"

zinput=%keyname

The %alt, %ctl, and %altctl modifiers operate on single standard ASCII characters (h20 - h7f). The % modifier operates on standard and extended characters (h20 - h0ff) in double quotes and on named keys

15 **zinputa** 2(int) Area ID of area causing the current zinput value (0 if zinput was not generated by an area); set when zinput updated

zinputainfo 8(int) Value of info tag for area that caused this branch

zinputf 4(bits) Keyboard and pointer status at last input

This variable is a set of bits numbered 1-32. Certain bits correspond to keyboard and pointer status as follows:

1 Insert turned on

2 CapsLock turned on

3 NumLock turned on

4 ScrollLock turned on

20

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- | | | |
|----|-----------------------|--|
| | 5 | either Alt key down |
| | 6 | either Ctrl key down |
| | 7 | left Shift key down |
| | 8 | right Shift down |
| 5 | 9 | SysReq key down |
| | 10 | CapsLock key down |
| | 11 | NumLock key down |
| | 12 | ScrollLock key down |
| | 13 | right Alt key down |
| 10 | 14 | right Ctrl key down |
| | 15 | left Alt key down |
| | 16 | left Ctrl key down |
| | 17 | enhanced keyboard "extra" key |
| | 18 | key is from Alt+numbers |
| 15 | 19 | key is from pointer action |
| | 20 | key is from "pointer up" action |
| | 21 | key is from touch device |
| | (bits 22-29 reserved) | |
| | 30 | middle mouse button pressed (Some mice produce bits 31 & 32 instead of |
| 20 | 30 | on a middle button press) |
| | 31 | right mouse button pressed |
| | 32 | left mouse button pressed |

Use the bit() function to test "zinputf". For instance, bit(zinputf,2) is 1 if

CapsLock was turned on during the input in "zinput", and 0 if not.

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	zinputx	2(int)	Graphics x location of pointer when "zinput" was last updated	
	zinputy	2(int)	Graphics y location of pointer when "zinput" was last updated	
	zintincr	2(int)	Minimum significant increment for I value in -palette	
	zintnum	1(int)	Interrupt number used by TenCORE device drivers	
5	zkeyset	2(int)	shift flag byte and scan code of last key processed. high byte = shift flags low byte = scan code The high byte is a set of bits numbered 1-8, duplicating the first eight bits in "zinputf".	
10			The low byte is a "scan code" identifying a physical key	
	zldisk	1(int)	Drive from which the currently executing lesson was loaded. 1,2,3...=A:,B:,C:,...; -2=system drive	
	zlength	2(int)	Length of judging buffer after -put	
	zlesson	8(alpha)	File name of current unit	
15	zldent	8(alpha)	Identification stored in current binary file	
	zline	2(int)	Current character line	
	zlinfo	2(int)	Number of bytes of associated information for the attached file; has no meaning for dataset files	
	zlname	2(int)	Maximum length of a name in characters for the attached file; has no meaning for dataset files	
20				
	zmainl	8(alpha)	File name of main unit	
	zmainu	8(alpha)	Unit name of main unit	
	zmargin	2(int)	x-coordinate of left text margin	
	zmaxarea	2(int)	Maximum number of areas; default=1000	

zmaxcol 2(int) Maximum number of colors available on current display

zmaxdom 2(int) Maximum number of domains allowed

zmaxflow 2(int) Maximum number of flow branches that can be defined

zmaxpage 2(int) Number of available hardware display pages

5 **zmlength** 4(int) Size, in bytes, of the last-referenced memory block.

Due to Windows memory management and disk swapfile, the effective memory pool size is generally more than large enough for most TenCORE needs on a typical Windows system. However, you should always check zreturn because it is possible for memory-related commands to fail, particularly on Windows systems with low memory. For compatibility reasons, the system variables zmem, zrmem and zfmem never return a value greater than 512K (524,288). However, if enough memory is available, a memory block as large as 1,048,560 bytes (hex FFFF0) can be created. Also for compatibility reasons, zxmem always returns a value of 0.

zmem 4(int) Current size, in bytes, of memory pool

15 **zfmem** 4(int) Largest block that could be allocated in the memory pool

zrmem 4(int) Largest block that could be allocated in the memory pool

zxmem 4(int) Set to 0

zmode 2(int) Current screen display mode

0 = inverse 3 = write 6 = add

20 1 = rewrite 4 = noplot 7 = sub

2 = erase 5 = xor

zmouse 1(int) Indicates if the mouse device driver is loaded:

-1 = mouse driver loaded;

0 = not loaded

	zmstart	4(int) Absolute address of the last-referenced memory block. The top two bytes are the segment and the bottom two bytes are zero to conform to a standard absloc address usable in memloc(a,zmstart)
	zmxnames	4(int) Maximum number of names permitted in the attached nameset type file
5	zname	8(alpha)First 8 characters of the selected name in the attached file; has no meaning for dataset files
	zndisks	1(int) Number of drives defined within DOS as set by LASTDRIVE= in CONFIG.SYS
	znindex	2(int) Position of the selected name within the attached nameset type file
10	znumber	2(int) Number of replacements made with -put
	zoriginx	2(int) Relative x-coord of origin as set with -origin
	zoriginy	2(int) Relative y-coord of origin as set with -origin
	zpalincr	2(int) Minimum significant increment for R, G, and B values in -palette
15	zpcolo	2(int) Color of dot of last pointer input location; in text mode, foreground color of character
	zplotxh	2(int) Upper x text extent (see text measure
	zplotxl	2(int) Lower x text extent (see text measure
	zplotyh	2(int) Upper y text extent (see text measure
	zplotyl	2(int) Lower y text extent (see text measure
20	zrec	4(int) Number of records associated with the selected name in the attached file; for datasets equals "zfrecs"
	zreturn	1(int) Indicates the success or failure of a command which sets this system variable. "zreturn" is generally set by commands which access disk or the TenCORE memory pool. Possible values for "zreturn" are:

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- 2 Redundant operation
(no action taken)
- 1 Operation successful
- 0 Disk Error; see "zdoserr"
- 5 1 No file attached
- 2 Block out of range
- 3 Memory or value out of range
- 4 Does not exist
- 5 Invalid device selected
- 10 6 Duplicate name
- 7 Directory full
- 8 Insufficient disk records
- 9 No name in effect
- 10 Name or block not found 11 Invalid type
- 15 12 Invalid name length
- 13 Invalid information length
- 14 Too many names/records in nameset
- 15 Nameset directory corrupted
- 16 Invalid name
- 20 17 Invalid image or data
- 18 Unable to fill memory pool requests
- 19 Operation invalid in context
- 20 datain- on locked data
- 21 Conflict with another user's lock

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	22	Too many locks on one name	
	23	Screen coordinate out of range	
	24	Required name/record lock not found	
	zrmargin	2(int) x-coordinate of right text margin	
5	zrotate	2(int) Number of degrees of rotation	
	zrotatex	2(int) x-coordinate of rotation origin	
	zrotatey	2(int) y-coordinate of rotation origin	
	zrpage	1(int) Display read page set by -page	
	zrestartl	8(alpha)Lesson name of restart unit, set by -restart	
10	zrestartu	8(alpha)Unit name of restart unit, set by -restart	
	zscaleox	2(int) x-coordinate of scaling origin	
	zscaleoy	2(int) y-coordinate of scaling origin	
	zscalex	8(real)x-scaling factor	
	zscaley	8(real)y-scaling factor	
15	zscreen	1(int) Current hardware (BIOS) screen:	
	0, 1	40 x 25 text	cga,text,medium
	4, 5	320x200 graph 4 color	cga,graphics,medium
	6	640x200 graph 2 color	cga,graphics,high
	7	80 x 25 mono text	mda
20	13	320x200 graph 16 color	ega,graphics,low
	14	640x200 graph 16 color	ega,graphics,medium
	16	640x350 graph 16 color	ega,graphics,high
	17	640x480 graph 2 color	mcga,graphics,high
	18	640x480 graph 16 color	vga,graphics,medium

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	19	320x200 graph 256 color	mcga,graphics,medium	
	zscreenc	1(int)	Current screen color type, as selected with the -screen- command: 0 = color; 1 = mono	
5	zscreenh	1(int)	Screen hardware driver (*.DIS file); adjusted for display hardware actually detected:	
	0	cga	10 vga	
	2	hercules	11 mcga	
	3	ega	4 evga	
	9	att		
10	zscreenm	1(int)	Current screen mode, as selected with the -screen- command: 0 = graphics, 1 = text	
	zscreenr	1(int)	Current screen resolution, as selected with the -screen- command:	
	0	low	2 high	
	1	medium	3 alt1	
15		4 alt2	5 alt3	
	zscreent	1(int)	Current screen type, as selected with the -screen- command:	
	0	cga	5 ncr	10 vga
	1	tecmar	6(reserved)	11 mcga
	2	hercules	7(reserved)	12 online
20		3 ega	8 nokia	13 (reserved)
	4	(reserved)	9 att	14 evga
	zsdisk	4(bits)	Bitmap of drives to include in automatic searches, set in DOS by SET TCSEARCH=	
	zserial	8(alpha)	8-character serial number of TenCORE executor	

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	zsetret	1(int) Kind of match found when -setname- is executed; possible values are:
		N Unique partial match (N-1 chars)
		-1 Exact match; a name is selected
		0 No match; selection cleared, no name selected
5		+N Non-unique partial match (N chars); first partially matching name selected
	zspace	2(int) Current character column
	zsysver	4(alpha)TenCORE version in the form "X.XX"
	ztelmain	4(int) Elapsed time spent in previous main unit
	ztmmain	4(int) System clock at start of main unit
10	ztmunit	4(int) System clock at start of current unit
	zuncover	2(int) Current uncover key as set by uncover command
	zunit	8(alpha)Unit name of current unit
	zvars1	4(int) Total size of global variables, in bytes
	zwidth	1(int) Width of graphics lines set by -width-; affects draw, circle, ellipse,
15		polygon, and dot
	zwindows	2(int) Number of windows opened (besides initial window
	zwindowx	2(int) Absolute x-coord of lower left corner of window
	zwindowy	2(int) Absolute y-coord of lower left corner of window
	zwpage	1(int) Display write page set by -page
20	zx	2(int) Current graphic horizontal location
	zxmax	2(int) Maximum x-coordinate in current window
	zxycolor	2(int) Color of dot at current screen location
		In text mode, foreground color of character

zy 2(int) Current graphic vertical location

zymax 2(int) Maximum y-coordinate in current window

Displaying the Contents of Variables

Displaying Numeric Variables

5 Variables which contain numeric information can be displayed using the show command:

```
at            17:21
show        ztriea
```

The normal form is **show varname** where *varname* is the name of the variable to display.

For integers, **show** displays the first non-zero digit at the current screen location and
 10 displays up to 20 digits. For real numbers, it starts at the current screen location and displays up
 to 24 places, including a decimal point and three decimal places. This can be altered by adding
field and *right* tags, as in:

```
show        real8,2,6
```

which displays up to a total of twelve places (including the decimal point): six digits including
 15 trailing zeros are displayed to the right of the decimal point. In this case, if the value of "real8" is
 1.2345, it displays:

```
1.234500
(1        starting screen location)
```

Tabular Display

20 A second form of displaying numeric information, **showt**, right-justifies and space-fills the
 field when it displays a variable. This is useful for aligning columns of numbers. For example:

```
define    local
var1       ,8,r
var2       ,8,r
25 var3       ,8,r
```

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```

var4      ,8,r
define    end

set       var1      ⇐ 1.1, 20.02, 300.003, 4000.0004
at        5:5

5  showt   var1,12,4
at        6:5
showt     var2,12,4
at        7:5
showt     var3,12,4
10 at      8:5
showt     var4,12,4

```

The code above produces output similar to this:

15

```

1.1000
20.0200
300.0030
4000.0004

```

20

Hexadecimal Display

The **showh** command displays the contents of a variable using two hexadecimal base' 16 digits for each byte of the variable. For example:

```

25 calc     int4 ⇐ 32766
showh      int4

```

displays:

```
00007ffe
```

Unless the optional length tag is specified, **showh** displays as many digits as necessary to show the entire variable (2 digits for a one-byte variable; 4 digits for a two-byte variable; etc.).

Alphanumeric Display

Text information is usually displayed using the **showa** (for "show alphanumeric")

5 command.

```
packz    textbuf;;Good morning!
at       5:5
showa    textbuf          $$ displays Good morning"
```

10 The **showa** command displays characters for the length of the variable or for an optionally specified length.

```
showa    textbuf,6          $$ displays "Good m"
```

Embedded show

In practice, the **show** command and its variants are usually embedded in a **write** command, as in:

```
15 at       5:5
write    «show,real1»    «s,real1»    $$ 's' is for (s) how
        «showt,real1»    «t,real1»    $$ 't' for show (t)
        «showh,real1»    «h,real1»    $$ 'h' for show (h)
        «showa,text»     «a,text»     $$ 'a' for show(a)
```

20 Note that the abbreviations *s*, *t*, *h*, and *a* can also be used.

The characters « and » are called embed symbols. The left embedding symbol is produced by pressing [ALT][<], the right embed symbol is produced by pressing [ALT][>]

The general form for embedding a **show** command in a write is:

```
«command,expression»
```

25 Command is one of the **show** commands or its abbreviation; expression may be a number, a variable, or a calculation involving either, as in:

```
write    The Fahrenheit temperature is «s,9*celsius/5+32».
```

Assigning Values to Variables

Assigning values to variables is performed in various ways depending on the type of variable and the type of information to be stored in the variable.

5 Numeric Values

Values are assigned to numeric variables using the **calc** command:

```
define    local
ratio,4, real
define    end
```

10

```
calc      ratio  $\Leftarrow$  1 / 3
```

The general form of **calc** is:

```
calc      variable  $\Leftarrow$  expression
```

variable any author-defined numeric variable

15

\Leftarrow the *assignment arrow* (produced by pressing [ALT][A] is the operator

that assigns a value to the variable

expression a valid arithmetic and/or logical expression

In the example above, TenCORE calculates the value of 1 divided by 3 and stores it into the variable 'ratio'.

20

The **calc** command can be continued from one line to the next, as follows:

```
calc      a  $\Leftarrow$  1
           b  $\Leftarrow$  2
           c  $\Leftarrow$  b / 3
           d  $\Leftarrow$  c + b
```

The **calc** command above assigns values to four different variables without the necessity of repeating the command name on each line.

When a real value is assigned to an integer variable, the value is rounded to the nearest integer.

- 5 The **calc** command works only with valid numeric variables (i.e., 1-, 2-, 3-, 4-, and 8-byte integers, and 4- and 8-byte reals). It does not work with 5-, 6-, or 7-byte variables, or with any variable larger than 8 bytes.

- 10 The full range of arithmetic and logical operators which can be used with **calc**, as well as alternate ways of representing numeric values, are treated in the section **Ways of Representing Literal Data** later in this chapter.

Selective Forms

The **calc** command has two selective forms, **calcc** and **calcs**. For more information, see the respective command descriptions.

Text Values

- 15 Because the **calc** command works only with numeric variables, i.e. variables with a defined length of 1, 2, 3, 4 or 8 bytes, it is not suitable for assigning text to variables.

Text is assigned to variables using the **packz** command. Its general form is:

packz buffer; [length]; text

- 20 buffer the buffer to receive the text
- length an optional tag a variable to receive the number of characters assigned to
 variable (the **packz** command sets *length*, not the author)
- text the text information to assign to *variable*

The “z” on **packz** indicates that any bytes of *buffer* not used to store the text are zero filled. Without zeroing, packing “rose” into a buffer which already contained “geranium” would give “rosenium”. If zero filling is not desired, use the **pack** command.

```

define    local
5  sublen,2
    subject,40
define    end
*
packz     subject,sublen;Geography 101
10 *
    at      5:5
write     The heading «a,subject» is «s,sublen» bytes long.

```

The *length* tag can be omitted, leaving two adjacent semicolons between the variable and the text to be assigned:

```

15 packz     subject;;Geography 101
*
    at      5:5
write     The heading is «a,subject».

```

Like the **write** command, **packz** can be continued over several lines:

```

20 packz     text2;;This is line one.
    This is line two.
    This is line three.

```

Any of the **show** commands can be embedded in the text tag of the **packz** command just as they can be embedded in a **write** command:

```

25 packz     text;textlen;atomic weight of «a,element» is «s,weight».
    at      5:5
    show     text

```

When **showa** is embedded in a **packz** command, null characters(bytes with a value of 0) in the embedded variable are skipped over instead of being copied. If a special application requires that even the null characters be copied, the **showv** command can be used instead of **showa**. The **showv** command works just like **showa** with the important exception that even null characters are copied in a **packz** command or displayed in a **write** command.

The **showv** command has both an embedded form (abbreviated «v, ») and a non-embedded form, but is primarily intended for embedding in a **packz** command.

Selective Form

The **packz** command has a selective form called **packzc**. For more information, see the respective command descriptions.

Copying Non-numeric data

The easiest way to copy non-numeric data from one variable to another is to use the **move** command, which has the general form:

move	source, destination, length
source	any defined variable or a literal
destination	any defined variable
length	an expression specifying the number of bytes to move.

The following example copies the contents of the 40-byte variable “newname” into the variable “oldname”.

```
move      newname,oldname,40
```

Converting Text to Numbers

The **compute** command translates a string of numeric characters into a numeric value.

```
pack      text;text1;-12345
```

```
compute   text,text1,result
```

at 1:1
show result

The general form is

compute buffer, length, result

- 5 buffer the string of characters
- length the number of characters to convert
- result the variable in which to store the result

The string to be converted can contain:

- the digits 0 through 9
- 10 • the unary + and - characters (the positive or negative sign)
- one decimal point (period)

Any other characters within the string cause **compute** to fail, indicated by a **zreturn** value greater than -1. If it fails, **compute** makes no changes to the value stored in "result".

For extracting numeric information from the input at an **arrow**, see the **store** and **storen**
15 command descriptions.

Initialization of Variables

Author-defined global variables should normally be initialized before use. This is often accomplished in a program's startup unit using the **zero** command.

zero

20 The simplest form of zero sets a single variable to zero, whatever its defined length:

zero **username**

Another form of **zero** clears a specified number of bytes starting at the named variable.

zero **scores,22**

Here, it zeros 22 bytes starting at "scores". The general form for clearing a number of
25 bytes is:

zero variable,length

variable name of the variable at which to start

length the number of bytes to zero

Startup units often clear all of global variable space before assigning any values to

5 variables. This ensures that the lesson has a clean slate to work with.

For clearing global variable space,. the system variable **zvars1** gives the total number of bytes reserved for storage of global variables (including space which has not been defined). If "firstvar" is the first global variable defined, the following command zeroes all global variables:

zero firstvar, zvars1

10 If "firstvar" is not the first global variable defined, an area **zvars1** bytes in length would extend beyond the end of global variable space. In this case, the **zero** command above results in an execution error.

Local variables do not need to be explicitly set to zero. All of a unit's local variables are automatically zeroed when execution of the unit begins.

15 **set**

Another way of initializing variables is with the **set** command. Rather than zeroing variables, set assigns a series of values to consecutive variables:

define local

jan ,1

20 **feb ,1**

. \$\$ all twelve months

.

nov ,1

dec ,1

25 **define end**

```
set      jan ← 31, 28, 31, 30, 31, 30, 31, 31, 30, 31, 30, 31
```

5 This example assigns 31 to “jan”, 28 to “feb” and so on. It has the same effect as twelve **calc** commands.

The normal form of the tag is:

```
set      variable ← value list
```

variable the variable to assign the first value to.

10 *value list* the subsequent values that are assigned to locations
 following *variable*.

The **set** command does not perform any bounds checking: assignments are made based on the defined length of the variable named in the tag, regardless of how the subsequent variables are defined. In the above example, “jan” is defined as a 1-byte integer, so the values in the tag of the
15 **set** are assigned to the twelve bytes starting at “jan”. If the eleven variables defined immediately following “jan” are not all 1 byte long, they will not contain the expected values.

The **set** command has a selective form **setc**. For more information, see the respective command descriptions.

Comparison and Searching

20 Two variables can be compared using the **compare** command. This command returns the number of leading characters which match in the two comparison strings.

```
define   local
```

```
string1,26
```

```
string2,26
```

25 **result**,1

```
define    end
```

```
pack      string1;;abcdefghijklmnopqrstuvwxyz
```

```
pack      string2;;abcDEFGHIJKLMNOPQRSTUVWXYZ
```

```
5  compare string1,string2,26,result
```

This example compares “string1” to “string2” and sets “result” to the number of leading characters which matched; in this case 3, for ‘abc’.

The general form of the compare command is:

```
compare var1,var2,length,result
```

```
10          var1    one of the variables to compare
```

```
          var2    the other variable to compare
```

```
          length  the number of bytes to compare
```

```
          result  set to the position of the last matching byte. It is set to - 1 if var1 and
                  var2 are identical or 0 if they do not match at all
```

```
15  find
```

Variables can be searched for specific contents using the **find** command.

```
define      local
```

```
alphabet,   26
```

```
aiphalen,   2
```

```
20  location, 2
```

```
packz      alphabet;aiphalen;abcdefghijklmnopqrstuvwxyz
```

```
find        'ef',2,alphahet,aiphalen,1,location
```

This example searches the variable ‘alphabet’ for the string ‘ef’. It finds it and sets the variable “location” to 5 because ‘ef’ starts at the fifth byte in the search area.

The general form of the **find** command is:

135

find object, object-length, start-var, list-len, incr, location

object the value to search for. This can be a literal, a variable, or a buffer

object-length the length of the object to search for, in bytes.

start-var the variable at which to start the search

5 list-len the number of entries to search. An entry can be more than
one byte long, as specified by *incr*.

incr the length of each entry.

location the entry number at which *object* was found If *object* was
not found, *location* is set to -1.

10 Examples

The following examples assume definition of the following variables:

```
define        local
name         ,15    $$ name to search for
found        ,2     $$ position in list where "name" found
15 list(5)    , 15    $$ list of names
define            end
```

The variable "list" contains a list of 5 names, each of which occupies 15 characters. The contents of "list" are as follows:

john miller... mark ho.....sarah johnston.james heflin lisa berger

```
20        ␣1                ␣16                ␣31                ␣46                ␣61
```

Null characters have been shown as to improve their visibility, and numbers have been added to help in counting bytes.

Literal Object

The following **find** statement searches for the name *mark ho*:

```
25    find        'mark ho' ,7,list(1) ,5,15,found                $$ found will be 2
```

Because the name has fewer than 9 characters, it can be supplied as the text literal '*mark ho*'. Next comes the length of the object to find, 7 characters. The start of the list is given as *list(1)*, and its length as 5 entries of 15 bytes each.

After the search, the variable "found" contains the value 2 because *mark ho* is found at
 5 the second position (not the second byte) in the list.

Variable Object

Since names of more than 8 bytes cannot occur as text literals, they must be packed into variables. The following example locates *james heflin*.

```
packz    name;;james heflin
10 find    name,15,list(1),5,15,found
```

The variable "found" receives the value 4 because *james heflin* is found in the fourth position.

Byte-by-byte

To find a last name, a **find** like the following could be executed:

```
15 packz    name;;miller
find    name,6,list(1),75,1,found
```

When this example is executed, "found" receives the value 6.

The length of the name is given as 6 because this locates part of an entry, not an entire entry.

20 Similarly, the list is specified as 75 one-byte entries instead of 5 fifteen-byte entries. This causes **find** to look for *miller* starting at every character, not just at the start of each 15-byte name field. This illustrates that the object of the search can be longer than the nominal entry length provided to find.

Backwards by Entry

To search backwards, a negative value is given for the increment. The following example searches backwards from the end of the list for *john*, looking only at the beginning of each 15-byte entry:

```
5 find      'john' , 4 , list(1) , 5 , -15 , found
```

Here, “found” receives the value 1. Although the search proceeded backwards from the end of the list, the position is always counted from the beginning of the list.

Backwards by Byte

Another example of backwards searching is the following:

```
10 find      'john' , 4 , list(1) , 75 , -1 , found
```

In this case, an increment of -1 is used, causing find to look at every character starting from the end of the list.

In this case, “found” receives the value 37, because the first *john* found when searching backwards byte-by-byte occurs in *sarah johnston*. If the search had been in the forward direction.

```
15 john miller would have been found first, and “found” would have received the value 1.
```

Ways of Representing Literal Data

Data used in **calc** commands and other numeric contexts can be expressed in a number of literal forms.

For purposes of discussion, the term *literal* is used to identify a 1-, 2-, 3-, 4- or 8-byte value which is expressed directly rather than as a variable or an expression. Values of 5, 6 or 7 bytes can be used as literals, but are represented internally as 8-byte values.

Integer Literals

Any valid number written as a sequence of digits with no decimal point is an integer literal. An integer literal may have a leading plus or minus sign.

Real Literals

A real literal is distinguished from an integer literal by the presence of a decimal point. Even if there are no digits following the decimal point, the presence of the decimal point causes the value to be represented as a real value.

5 Text Literals

A text literal is a string of 1 to 8 characters enclosed in single quotation marks. Many commands allow file names, unit names or other block names to be written as text literals:

```
image    plot; 'pictures', 'bird'
```

The **image** command above displays a screen image stored in file **pictures**, block **bird**.

10 Text literals are always stored internally as 8 bytes; unused bytes at the right end of the text are zeroed. Another way of stating this is that text literals are stored *left-justified* in 8 bytes.

Because text literals are 8 bytes long, the **calc** command can be used to assign a text literal to an 8-byte variable:

```
calc     filename ← 'pictures'
```

15 The variable must have been defined to be 8 bytes long. If a shorter variable is used, characters are certain to be lost from the *beginning* of the text literal.

Character Literals

Character literals normally consist of a single character enclosed in double quotation marks:

```
20 if     name(2) = "a"
```

Such a character literal is stored internally as a single byte.

A character literal can be assigned directly to an integer-compatible variable using **calc**:

```
calc     name(2) ← "z"
```

It is also possible, although unusual, to create multiple-byte character literals by enclosing
25 a string of 2 to 8 characters in double quotes:

`calc chars ← "abc"`

Such a literal is always stored in the smallest possible of 1, 2, 3, 4 or 8 bytes. If the literal contains 5, 6 or 7 characters, zero-valued bytes are added to the *left* end of the literal to round its length up to 8 bytes. Another way of saying this is that character literals are stored *right-justified* in the smallest possible size of 1, 2, 3, 4 or 8 bytes.

Multi-byte character literals (enclosed in double quotes) are not a substitute for text literals (enclosed in single quotes). Correct usage is to use single quotes for all textual literals such as file names and unit names, and to reserve double quotes for single characters.

Keypress Literals

When examining the system-defined variable **zinput**, which reports the last key processed, one often uses *keypress literals*.

A keypress literal is normally a 1-byte character literal prefixed with a percent sign as follows: `%“a”`. The percent sign changes the 1-byte character literal into a 2-byte internal representation consistent with **zinput**.

A number of other prefixes exist as well: `%alt`, `%ctl`, `%altctl` and `%ctlalt` (the last two are equivalent). Thus, to determine whether the last key processed was [CTRL][A] one could write

```
if zinput = %ctl"a"
```

All keypress literals are represented internally as two byte positive values. The detailed format can be found under the description of **zinput**.

Hexadecimal Literals

This discussion of hexadecimal (base 16) literals should be considered optional advanced material. If you have not used hexadecimal numbers before, you probably do not need this information and you may want to skip ahead to *Constants*.

A hexadecimal literal is written as the letter *h* followed by a digit 0 - 9, followed by zero or more of the hexadecimal digits 0 - 9 and *a - f* (In hexadecimal notation, the values 10 through 15 are represented by the letters *a* through *f*.)

Thus the following are valid hexadecimal literals:

```

5  h4      (equals decimal      4)
   h10     (equals decimal     16)
   h0f     (equals decimal     15)
   h1ec4   (equals decimal    7876)
   hffff   (equals decimal    -1)

```

10 Note that *hf* would not be a valid hexadecimal literal, since the first digit after *h* must be within the range 0 - 9. Any time the first digit of the hexadecimal value is one of *a* through *f*, an extra 0 must appear after the *h* as in: *h0f*.

It is useful to think of hexadecimal literals as being evaluated “backwards”, from right to left. The digits of the literal are read in pairs, starting from the right, and each pair of digits
 15 corresponds to one byte in the internal representation of the value. Each new pair of digits causes a new byte to be added to the internal representation of the literal. A lone, unpaired digit remaining at the left end of the literal also causes another byte to be added, *unless the remaining digit is zero*. A lone, unpaired zero at the left end of the literal is always discarded. If the resulting internal representation is 5, 6 or 7 bytes long, zero-valued bytes are added to the left of the value
 20 to pad it out to 8 bytes.

Hexadecimal Literals as Integer Values

In calculations, a hexadecimal literal is always considered an integer value. When assigning a hexadecimal literal to a variable, it is important to distinguish between the length of the variable and the length of the literal. Consider the following example:

```

25  define      local

```

```

temp, 4
define      end
*
calc      temp <= h91

```

- 5 Here the value of a 1-byte literal is assigned to a 4-byte integer variable. The integer value of the literal is evaluated before considering the length of the variable. Since the literal is one byte long, its value is h91, which corresponds to the binary value 10010001. Because the leftmost bit is a '1', the value is interpreted as a negative number: 111. This is the value assigned to the variable "temp". Note that the two-byte literal h0091 or the four-byte literal h00000091 would
- 10 have given a different result, namely the positive number 145. This is why it is important to pay attention to the length of a hexadecimal literal.

Hexadecimal Literals as Bit Patterns

- It is sometimes desirable to use a hexadecimal literal to assign a particular pattern of bits to a real variable. This cannot be done using **calc**, because a calculation would interpret the
- 15 hexadecimal literal as an integer, and then convert the value of the integer to the IEEE format used to store real numbers in TenCORE. The numeric value would be preserved, but the bit pattern would not.

The **move** command can be used to copy a hexadecimal literal into a variable as a bit pattern without any numeric interpretation:

- ```

20 define local
 height, 4, real
 define end
 *
25 move h7f800000, height, 4

```

This example copies the 4-byte bit pattern for the indefinite value 1/0 into the 4-byte real variable "height". Because no calculation is performed, no conversion of the bit pattern takes place.

### Constants

5           A constant is a named item of literal data. Constants can be defined globally or locally using the = sign:

```
a=1
```

```
greet=' Hello'
```

10           The general syntax for constant definition is *name=literal*. A constant can be given any name which is valid for a variable. Constant definitions can occur at any point where a variable definition can occur. Once defined, a constant can be used anywhere that the literal data it represents could be used:

```
define local
```

```
Picfile='pictures'
```

15   picblock='fish'

```
Px=140
```

```
Py=100
```

```
define end
```

```
*
```

20   image     plot;block,Picfile,Picblock;Px,Py

The **image** command above is equivalent to:

```
image plot;block,'pictures','fish';140,100
```

Constants are often defined for use in defining other variables:

```
MAXNAMES=20
```

25   name (MAXNAMES) ,20

```
age (MAXNAMES) ,2
```

`address (MAXNAMES) , 40`

This example defines three arrays of length 20. The lengths of all three arrays can be changed by changing the definition of MAXNAMES.

Many programmers make a convention of using upper-case characters for names of constants so they are not easily confused with variable names.

The same rules apply to literals used in constant definitions as to literals used anywhere else. A constant has a value, a type (integer or real), and a length (the number of bytes in the internal representation). As with other literal data, all three of these characteristics must sometimes be considered when using a constant in a calculation.

## 10 Operators

TenCORE supports a rich variety of operators which can be used to combine literals, constants and variables into numeric expressions. In addition, TenCORE supports a number of mathematical functions and provides a mechanism for the author to define other functions.

### Arithmetic Operators

|    |              |                                                                                        |
|----|--------------|----------------------------------------------------------------------------------------|
| 15 | +            | Addition                                                                               |
|    | $\Leftarrow$ | Assignment (e.g., $a \Leftarrow b$ means assign b value to a) [CTRL][C][A] or [ALT][A] |
|    | -            | Subtraction                                                                            |
|    | * or x       | Multiplication, real arithmetic [CTRL][C][+]                                           |
| 20 | Simul\$      | Multiplication, integer arithmetic                                                     |
|    | or÷          | Division, real arithmetic {CTRL}[C][/]                                                 |
|    | \$idiv\$     | Division, integer arithmetic                                                           |
|    | **           | Exponent (e.g., $a ** b$ means a to the b power)                                       |
|    | °            | Convert preceding value from degrees to radians [CTRL][C][°]                           |

## Logical Operators

Logical operators compare expressions and return values corresponding to true or false.

For example, the command sequence:

```

if 2 < 3
5 . write True
endif

```

plots True because 2 is less than 3. This is similar to posing the question:

True or false: Two is less than three.

Logical operators compare the operands in an expression and then return value - 1 if the  
 10 expression is true, 0 if false. Key sequences used to enter non-standard characters are shown.

|    |         |                                                                                           |
|----|---------|-------------------------------------------------------------------------------------------|
|    | =       | Equal to (true if operands are identical)                                                 |
|    | ≠       | Not equal to (true if operands are not identical)                                         |
|    | <       | Less than (true if left operand is less than right operand)                               |
|    | >       | Greater than (true if left operand is greater than right operand)                         |
| 15 | ≤       | Less than or equal to (true if left operand is less than or equal to right operand)       |
|    | ≥       | Greater than or equal to (true if left operand is greater than or equal to right operand) |
|    | \$and\$ | Logical "and" (true if both operands are true)                                            |
| 20 | \$or\$  | Logical "or" (true if either operand is true)                                             |

In addition to the operators above, the **not()** function returns true if the operand in parentheses is false and vice versa.

The operands of a logical operator do not have to be numeric values; for example, ASCII characters can be compared with each other.



In TenCORE, true is represented by a value of -1 and false is represented by a value of 0.

For example, some expressions and their numeric values are:

```

2 < 3 $$ returns -1, true
2 = 3 $$ returns 0, false
5 2 > 3 $$ returns 0, false
not(2 > 3) $$ returns -1, true (true is the same as not false)

```

More generally, TenCORE treats any negative value as true and any non-negative value as false.

Because true and false have associated numeric values, a logical expression is often used as the selector in the selective form of a command:

```
writeln 2<3;True;False
```

This example prints *True* because 2 is less than 3 and the result of the expression is thus -1; had the expression been false, the numeric value would have been 0 and the example would have printed *False*.

Although logical operators are normally used in combination with each other, they are occasionally used together with arithmetic operators as in the following:

```

calc score ← score - (answer=correct)
* increments "score" by 1 if answer=correct

```

This has the effect of leaving "score" unchanged if the values of "answer" and "correct" are different. This is because the value of *answer=correct* will be False (0), and the value assigned to "score" is *score - (0)*. But if the values of "answer" and "correct" are equal, then *answer=correct* has the value True (-1) and the value assigned to "score" is *score - (-1)*, which is equivalent to *score + 1*.

### Bitwise Operators

Bitwise operators treat each operand as a pattern of bits rather than as a numeric value.

The bitwise operators and the operations they perform are:

|           |                                                                                                                                                                                                                                            |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| \$mask\$  | Logical "and". Each bit in the result is set if the corresponding bit is set in both operands                                                                                                                                              |
| \$union\$ | Logical "or". Each bit in the result is set if the corresponding bit is set in either operand.                                                                                                                                             |
| \$diff\$  | Logical "exclusive or". Each bit in the result is set if the corresponding bit is set in one of the operands and not set in the other operand.                                                                                             |
| \$ars\$   | Arithmetic Right Shift. The bit pattern in the first operand is shifted right by the number of places given in the second operand. The leftmost (sign) bit propagates to the right, and bits which "fall off" the right end are discarded. |
| \$cls1\$  | Circular Left Shift in 1 byte. The bit pattern in the first operand is circularly shifted leftwards for the number of places given in the second operand. Bits shifted out of the left end of the byte re-appear in the right end.         |
| \$cls2\$  | Circular Left Shift in 2 bytes.                                                                                                                                                                                                            |
| \$cls3\$  | Circular Left Shift in 3 bytes.                                                                                                                                                                                                            |
| \$cls4\$  | Circular Left Shift in 4 bytes.                                                                                                                                                                                                            |
| \$cls8\$  | Circular Left Shift in 8 bytes.                                                                                                                                                                                                            |

For example, \$mask\$, \$union\$ and \$diff\$ produce the following results:

|    | \$mask\$ | \$union\$ | \$diff\$ |
|----|----------|-----------|----------|
| 45 | 00101101 | 00101101  | 00101101 |
| 84 | 01010100 | 01010100  | 01010100 |
|    | -----    | -----     | -----    |

121        00000100 01111101        01111001

Thus 45 \$mask\$ 84 equals 4; 45 \$union\$ 84 equals 125; and 45 \$diff\$ 84 equals 121.

Bitwise operators are intended to operate only on integer values and non-numeric values with valid integer sizes (1 ,2 ,3 ,4 or 8 bytes). They are not suited for use with real values.

## 5 System-Defined Functions

TenCORE supports a number of system-defined functions which take an argument in parentheses. These include trigonometric, logarithmic, logical, arithmetic and address functions.

### Logarithmic

|    |           |                                                              |
|----|-----------|--------------------------------------------------------------|
|    | alog(x)   | Antilogarithm base 10 of x (10 to the x <sup>th</sup> power) |
| 10 | exp(x)    | Math constant C to the x <sup>th</sup> power                 |
|    | ln(x)     | Natural logarithm of x                                       |
|    | log(x)    | Logarithm base 10 of x                                       |
|    | logx(n,x) | Logarithm base n of x                                        |

### Negation

|    |         |                                                                                                                   |
|----|---------|-------------------------------------------------------------------------------------------------------------------|
| 15 | comp(x) | Bitwise complementation. All bits in operand x are inverted (bits containing '1' are reset to 0' and vice versa). |
|    | not(x)  | Logical negation. Returns true (-1) if operand x is false and vice versa.                                         |

### Trigonometric

|    |         |                            |
|----|---------|----------------------------|
|    | acos(x) | Arc cosine (x in radians)  |
| 20 | asin(x) | Arc sine (x in radians)    |
|    | atan(x) | Arc tangent (x in radians) |
|    | cos(x)  | Cosine (x in radians)      |
|    | sin(x)  | Sine (x in radians)        |
|    | tan(x)  | Tangent (x in radians)     |

**Address**

|   |                |                                                                    |
|---|----------------|--------------------------------------------------------------------|
|   | absloc(v)      | 4-byte absolute address in memory of variable v                    |
|   | sysloc(global) | Segment address of global variable space                           |
|   | sysloc(local)  | Segment address of local variable space for current unit           |
| 5 | varloc(v)      | Offset from start of local or global variable space for variable v |

**Arithmetic**

|    |             |                                                                  |
|----|-------------|------------------------------------------------------------------|
|    | abs(x)      | Absolute value of x                                              |
|    | bit(v,x)    | Logical value of bit x in variable v (-1 if the bit is 1)        |
|    | bitcnt(v,n) | Number of bits set in variable or buffer V, in a range of n bits |
| 10 | frac(x)     | Fractional part of x                                             |
|    | imod(x,y)   | x modulo y                                                       |
|    | int(x)      | Integer part of variable x                                       |
|    | mod(x,y)    | x modulo y                                                       |
|    | randi(x)    | Random integer from 1 to x                                       |
| 15 | randi(x,y)  | Random integer from x to y                                       |
|    | randr(x)    | Random real value from 0.0 to x                                  |
|    | randr(x,y)  | Random real value from x to y                                    |
|    | round(x)    | x rounded to the closest even integer                            |
|    | sign(x)     | -1 if x is negative                                              |
| 20 |             | 0 if variable x is positive                                      |
|    | sqrt(x)     | Square root of x                                                 |
|    | $\pi$       | Pi(3.14159265358979312) [CTRL][C][P]                             |

## Evaluation of Expressions

This section discusses the details of how TenCORE evaluates expressions. The first part, Precedence of Operators, is useful to all authors. The remainder of the material can be regarded as optional information for authors who need to optimize calculations for maximum possible efficiency of execution.

### Precedence of Operators and Functions

TenCORE observes a certain precedence of operators in evaluating expressions. Thus the expression  $5 + 4 * 3$  equals 17 instead of 27 because the multiplication operator  $*$  has a higher precedence than the addition operator  $+$ , and is executed first. This makes the expression  $5 + 12$  instead of  $9 * 3$

Parentheses override the normal order; operations within the parentheses are done first (in normal order). The resulting value is then used in the related operation in the expression. The following table shows the TenCORE operators and functions in the order in which they are performed. Class 1 is performed before class 2, 2 before 3, and so on.

|    |   |                                                                                                                        |
|----|---|------------------------------------------------------------------------------------------------------------------------|
| 15 | 1 | Exponentiation ( $**$ ) and Functions                                                                                  |
|    | 2 | Unary Minus and Unary Plus                                                                                             |
|    | 3 | Multiplication and Division ( $*$ , $/$ , $\div$ , $\text{\$simul\$}$ , $\text{\$div\$}$ )                             |
|    | 4 | Addition and Subtraction ( $+$ , $-$ )                                                                                 |
|    | 5 | Bitwise Operators ( $\text{\$union\$}$ , $\text{\$mask\$}$ , $\text{\$diff\$}$ ,                                       |
| 20 |   | $\text{\$ars\$}$ , $\text{\$cls1\$}$ , $\text{\$cls2\$}$ , $\text{\$cls3\$}$ , $\text{\$cls4\$}$ , $\text{\$cls8\$}$ ) |
|    | 6 | Comparison Operators ( $=$ , $\neq$ , $<$ , $>$ , $\leq$ , $\geq$ )                                                    |
|    | 7 | Logical Operators ( $\text{\$and\$}$ , $\text{\$or\$}$ )                                                               |
|    | 8 | Degree-to-Radian Conversion ( $^{\circ}$ as in $45^{\circ}$ )                                                          |

## 9 Assignment ( $\Leftarrow$ )

### Rounding

Rounding of a value with a fractional part exactly equal to .5 always yields an even integer. Another way of stating this is that values where the fractional part is .5:

- 5      • round up if the integer part is odd
- round down if the integer part is even

### Example

```
calc intvar \Leftarrow 7.5 $$ "intvar" assigned the value 8
 intvar \Leftarrow 8.5 $$ "intvar" assigned the value 8
```

## 10 Compression of Sub-Expressions

Some sub-expressions are evaluated and compressed when a unit is translated to binary form rather than when it is executed:

```
calc ratio \Leftarrow (4 + 5) / limit
```

- Because the sub-expression (4+5) contains only integers and its value is known already before the program is run, the command would be represented internally as:

```
calc ratio \Leftarrow 9 / limit
```

To qualify for evaluation and compression at translation time, a sub-expression must contain only:

- integer literals which fit in 4 bytes or less
- 20      • integer constants which fit in 4 bytes or less
- the operators + - \$imuls \$idiv\$

Sub-expressions containing other elements cannot be evaluated at condense time and are not compressed.

## Operator Types

Certain operators and functions work exclusively on a particular type of value, either real or integer. Non-conforming values are internally converted into the type expected by the operator or function before any operation is performed.

5 Operators which work with real values are:

|    |                             |
|----|-----------------------------|
| *  | real multiplication         |
| /  | real division               |
| ** | exponentiation              |
| °  | degree-to-radian conversion |

10 In addition, the trigonometric functions, exponential and logarithmic functions, and `int()`, `frac()` and `round()` always work with real values.

When these operators and functions are used with integer operands, the operands are first converted to real values. If the result is assigned to an integer variable or used in a command which expects an integer value, the result is converted back to integer.

15 Operators which work only with integer values are:

|                      |                        |
|----------------------|------------------------|
| <code>\$mul\$</code> | integer multiplication |
| <code>\$div\$</code> | integer division       |

In addition, the logical and bitwise operators, and the functions `imod()`, `not()` and `comp()`, always work with integer values.

20 When these operators and functions are used with real operands, the operands are first converted to integer values. If the result is assigned to a real variable, it is converted to real before assignment.

Other operators and functions can work on real or integer values and do not perform any internal conversions.

Operator types normally affect only a program's speed of execution. However, certain integer operators applied to real values may give unexpected results if the implicit conversion is not kept in mind. The bitwise operators in particular, together with the `comp()` function, don't really give meaningful results when applied to real values.

## 5      **Intermediate Values and Speed Optimization**

A TenCORE author usually does not need to know how intermediate values used in evaluating expressions are represented internally, as the internal representation does not affect the correctness of the result. However, the information can be useful in optimizing calculations for speed.

10      Intermediate values are always represented as either 4-byte integers or extended-precision 10-byte reals. Four-byte integers are used if all three of the following conditions are met:

- none of the operands are real
- none of the operators require real values
- none of the operands are longer than 4 bytes

15      If any of the above conditions are not met, 10-byte reals are used. Since 10-byte real calculations take several times as long as 4-byte integer calculations, a single real operand in an otherwise (4-byte) integer expression can significantly slow down its evaluation. In practice, this is usually significant only in particularly speed-critical applications, especially if a math coprocessor is not present.

## 20      **Author- Defined Functions**

An author-defined function is a named expression. Like constants, functions are defined using the = sign:

```
pressure = weight / area
```



The simplest syntax for function definition is *name=expression*. A function can have any name which is valid for a variable. Function definitions can occur at any point where a variable definition can occur. Once defined, a function can be used anywhere that the expression it represents could be used.

## 5        **Arguments**

Functions can be defined with arguments:

```
fahr(xx) = 9 * xx / 5 + 32
inrange(aa,bb,cc) = aa ≤ bb and bb ≤ cc
```

The function "fahr()" defined above gives the Fahrenheit equivalent of a Celsius  
10 temperature. It could be used as follows:

```
write 15° celsius is «s,fahr(15)» Fahrenheit
```

The function "inrange()" determines whether one value lies between two others, returning true or false. It could be used as follows:

```
if inrange(100,zinputx,200) and inrange(140,zinputy,180)
15 . write Good! You pointed inside the box.
endif
```

This example checks whether the last pointer input (given by the system variables zinputx,zinputy) was within a rectangular area with opposite corners at 100,140 and 200,180.

The general syntax for defining a function with arguments is

20        *name(arg1,arg2,...,argn)=expression*

An argument can have any name which is valid for a variable, but must not duplicate the name of a variable which is already defined. Many authors use double letters such as aa, bb, etc., to minimize the likelihood of using an argument name which conflicts with a variable or constant name.

The purpose of author-defined functions is to improve readability of source code and to simplify changes. When a program is translated to binary form, each reference to a function is expanded to the full length of the definition. Using functions thus has no effect on the final size or efficiency of a program.

## 5      **Reduction to Constants**

Any integer-valued function which can be entirely evaluated and compressed at condense time is reduced to a constant (see the Compression of Sub-Expressions section earlier in this chapter). Thus the following two definitions are equivalent:

```
length = 4 + 256 + 128
```

10

```
length = 388
```

Reduction of simple functions to constants is particularly useful when defining variables, as it makes possible constructions like the following:

```
define local
```

15

```
HEADER = 4
```

```
ENTRIES = 20
```

```
LENGTH = HEADER + ENTRIES
```

```
list(LENGTH), 1
```

```
define end
```

## 20      **Type and Length**

Like literals, constants, and variables, functions have an associated type and length. These are determined according to the rules given above for evaluating expressions. Thus the value of a function is always either a 4-byte integer or an 8-byte real. In practice, this is seldom significant, since TenCORE automatically performs any needed type conversions.

## Physical Allocation of Variable Space

In keeping with the differences in characteristics and usage between global and local variables discussed in chapter 4, they are stored in different physical segments of the computer 8 memory.

### 5 Global Variable Storage

Global variables occupy a segment of memory which is reserved when TenCORE is started and is preserved until TenCORE is exited. There is only one segment of memory used for global storage. Every defines block and every **define global** statement allocates storage for variables starting at the beginning of this single segment.

10 The system-defined variable **zvars1** gives the length of the memory segment allotted for global variables.

### Local Variable Storage

Local variables occupy a segment of memory specific to the unit in which they are defined. Each unit has its own separate local storage segment which exists only as long is the unit 15 is active. This segment is reserved and zeroed when execution of the unit begins. When the unit is exited by branching to a new main unit, by reaching the end of the unit, or by exit via **return** or **goto q**), the space for that unit's local variables is released.

### Allocation of Space

20 Within a set of global or local defines, successive bytes of storage are allocated sequentially starting from the beginning of the global or local segment. For example:

| Defintion     | Location(offset from start of segment) |
|---------------|----------------------------------------|
| var1, 2       | Bytes 0 - 1                            |
| var2, 2       | Bytes 2 - 3                            |
| realvar, 8, r | Bytes 4 - 11                           |
| userrame, 40  | Bytes 12 - 51                          |

Two system-defined functions return the location of a variable within memory:

`varloc()` returns the offset within variable space (local or global)

`absloc()` returns the absolute location within computer memory

The starting byte of each variable above could be displayed as follows:

```

at 5:5
5 write var1 starts at byte «s,varloc(var1)»
 var2 starts at byte «s,varloc(var2)»
 realvar starts at byte «s,varloc(realvar)»
 username starts at byte «s,varloc(buffer)»

```

Bytes of storage can be skipped, as in:

```

10 var1,2
 ,4
 var2,2

```

where `,4` allocates four bytes as unused.

### Absolute Definition

15 Variables can be defined at an absolute offset (from the beginning of local or global space, as appropriate) by using the format:

`@offset, name, length, type`

where the `@` symbol indicates that the variable is to start at the specified location. For example:

```

20 @0,first,1 $$ first byte of variable space
 @1000,name, 8, i $$ 8-byte integer at offset 1000

```

The variable "first" above could be used with `zero` to zero all global variables as follows:

```

zero first,zvars1

```

By defining "first" at an absolute location (rather than just placing it first in the defines block), the author guarantees that the `zero` command will always start with the first byte of global

25

storage, even if other variable definitions are inadvertently inserted before "first" in the defines block.

The offset for an absolutely defined variable may be given as a defined constant:

```
loc = 2000 $$ defined constant
5 @loc,xyz,r $$"xyz" starts at offset 2000
```

The use of absolute definition does not affect the allocation of subsequent variables-- allocation continues sequentially following the last variable which did not use absolute variable definition.

### Redefinition

10 A technique very similar to absolute definition is redefinition, in which a variable is defined to start at the same location as a previously defined variable. Redefinition takes the format:

@oldname, newname, bytes, type

where the @ symbol indicates that the variable newname is to start at the same location as

15 *oldname*. For example:

```
username,40 $$ full user name
@username,userchar,1 $$ first character redefined/1-byte integer
```

In this example, the variable "usercha" could be used with if to test whether the first character (and thus presumably the whole name) is null:

```
20 if userchar = 0
 . do getname
endif
```

As in the case of absolute definition, redefinition does not affect the allocation of subsequent variables: allocation continues sequentially following the last variable which did not

25 use redefinition.

## Segmentation

Variables may be broken down into smaller pieces or segments which can be referenced by name.

```

define local
5 systime ,4
 . hours ,1
 . minutes ,1
 . seconds ,1
 . hundr ,1
10 define end

clock systime
at 3:3
write time: «s,hours» hrs, «s,minutes» min, «s,aeconds» sec

```

15 With "systime" segmented as above, the bytes can be referenced collectively (as in the **clock** command) or individually (as in the **write** command).

The definition of a segment must follow the definition of the variable of which it is a part. A period must appear in the first position, then seven space characters (one tab), then the segment name and size.

20 Segmentation is sometimes used in defining buffers for disk operations, which always use 256-byte lengths of data.

```

record,256
 . name , 40
 . response (64) ,1
25 . score , 4
 time,4

```

Here, "record" reserves a full 256 bytes, even though the segments only need 40 + 64 + 4, or 108, bytes. This ensures that that one can read in a 256-byte disk record without affecting "time" or other neighboring variables.

As this example illustrates, segments do not have to add up to the full size of the segmented variable. However, they normally must not exceed it.

Only one level of indentation is allowed when defining segmented variables. If a segment needs to be further divided into sub-segments, this can be accomplished by combining segmentation and redefinition:

```

userid,20
10 . u.id1,10
 . u.div,1
 . u.id2,21
 *
 @u.id1,,10 $$ redefinition of u.id1
15 . u.id1.a,1
 . u.id1.b,9

```

No name was given to the redefined variable. It could have been given a unique name such as "xuid1", but since the only purpose was to (sub-)segment "u.id1", it was simpler to omit the name.

The use of period (.) in variable names has no special meaning in TenCORE, which treats the period just like any other valid character, but does give visual emphasis to the logical structure.

### Array Segmentation

Segmentation of arrays is similar to segmentation of individual (*scalar*) variables.

However, when an array is segmented, each segment is itself an array, even though no array size is given.

```

define local

systime(3) ,4
. hours ,1
. minutes ,1
5 . seconds ,1
. hundr ,1

define end

*

clock systime(1)
10 clock systime(2)
clock systime(3)

*

write The three times are:

15 «s,hours(1)» hrs, «s,minutes(1)» min, «s,seconds(1)» seconds
 «s.hours(2)» hrs, «s,minutes(2)» min, «s,seconds(2)» seconds
 «s,hours(3)» hrs, «s,minutes(3)» min, «s,seconds(3)» seconds

```

Because the variable "systime(3)" was defined as an array with 3 elements, each of the segments "hours", "minutes", "seconds" and "hundr" is treated as an array which is referenced with an index in parentheses.

### Special Segmentation

In certain cases, especially with arrays, it is desirable to segment beyond the defined length of a variable. Normally, this would result in an error when the program is compiled before execution. However, by adding the keyword **special** (abbreviated **s**) after a segment definition, the check for segmenting beyond the length of the original variable is omitted. The defaults for variable definitions cannot be used with this keyword: the length and type must be explicitly specified, with the keyword **special** added after the type.



Segmentation beyond the end of a variable does not cause any more bytes to be allocated in variables. After the special segments are defined, the next variable starts at the location after the last normally defined variable.

### Example

5           Shows how one could define a data area containing mixed data types: two-byte integers and eight-byte integers. Each piece of data is prefixed by a single byte indicating which type of data follows.

```
data,8192
```

```
@data,buf1(8192),1
```

```
10 . type1,1,i,s $$ prefix byte
 . data1,2,i,s $$ access 2-byte words at any byte
@data,buf2 (8192),1
 . type2,1,i,s $$ prefix byte
 . data2,8,i,s $$ access 8-byte words at any byte
15 newvar,1 $$ starts 8192 bytes after "data"
```

```
 $$ newar is overwritten by special segments
```

By knowing the starting byte of an individual entry, the type can be determined and the appropriate variable name ("data1" or "data2") used to access the data in the appropriate format. The next entry would be found by incrementing the index into the array by the length of the

20   current entry (3 or 9).

### Blocks

A technique similar to segmentation but applicable on a larger scale is the variable block. Defining a variable block reserves a section of variable space. Within the variable block, scalar and array variables can be defined and segmented.

25           The normal format for defining a variable block is:

*name, size, block*

where *name* is any name valid for a variable; *size* is the number of bytes to reserve for the block; and **block** indicates that this is a variable block (**block** can be abbreviated as **b**).

The following example defines a 256-byte block named "diskio":

```

5 diskio,256,block $$ 256-byte data area for disk input/output
 ,10 $$ 10 bytes unused
 name,20 $$ user's name
 date,6 $$ date of last use
 time,4 $$ time of last use
10 . hours ,1
 . minutes ,1
 . seconds ,1
 . hund ,1
 score,2 $$ most recent test score
15 status,256,block $$ next block begins here

```

Once a variable block is defined, all subsequent variable definitions are part of the defined block, up to the next variable block definition. If definitions within a variable block use up more space than is reserved for the block, a compile error occurs.

When the length of the variable block is not known, the *size* argument can be left blank. In this case, the variable block is given whatever size is required to hold all variables subsequently defined, up until the next block definition.

### Sharing Definitions Among Source Files

If a program is spread over several source files, care must be taken to make the global variable definitions agree for each file. This is normally done by placing all the global definitions in one file and including a copy of the definitions in the other files with use commands:

**tax 1,globals (defines block)**

**lastname,15**

**firstnam,10**

**mi,1**

5 **stunum,9**

**p(64),1**

**score,4**

**tax 1a,globals (defines block)**

10 **use tax1,globals**

**tax 1b,globals (defines block)**

**use tax1,globals**

In this example, all of the variables for the files **tax1**, **tax1a** and **tax1b** are defined in **tax1**.

15 The **use** commands in **tax1a** and **tax1b** just include a copy of the definitions already made in **tax1**.

### **Sharing Some Definitions But Not Others**

Sometimes, it is desirable to define some variables which are used by an entire set of source files, and other variables which are unique to each individual source file. Since there is only one memory area for all global variables, the definitions of the variables for individual source files must naturally be coordinated to avoid conflicting definitions. This can be accomplished using a combination of variable blocks and redefinition.

20

The following example applies this technique to the files **tax1**, **tax1a** and **tax1b** by adding variables defined in **tax1a** and **tax1b**:

**tax1,globals (defines block)**

lastname,15

firstnam,10

mi,1

5     stunum,9

p(64),1

score,4

\*

tax1a,2048,block

10    tax1b,2048,block

**tax1a,globals (defines block)**

use           tax1,globals

\*

15    @tax1a,ownvars,2048,block

\*

xloc,2

yloc,2

interest,8,r

20

**tax1b,globals (defines block)**

use           tax1,globals

\*

@tax1b,ownvars, 2048,block

25    line11a,8,r

line11b,8,r

line12,8,r

In this example, the definitions used by all three files include the 2048-byte variable blocks "tax1a" and "tax1b". These variable blocks are data areas reserved for the source files of the same name. The source files **tax1a** and **tax1b** then redefine their own block using the name "ownvars" and define their own variables within this block. Making "ownvars" a block variable ensures that

5 the variable definitions in **tax1a** and **tax1b** do not extend beyond the areas reserved for them.

Unlike other redefined variables, redefined block variables permanently affect variable allocation. If **tax1a** defines another block after "ownvars", this block will conflict with the variables defined in **tax1b**.

### Accessing Other Memory Segments

10 Sometimes it is desirable to access data stored in areas of memory other than local and global variable space. This can be accomplished using the **transfr** and **exchang** commands.

#### **transfr**

The **transfr** command transfers data from one place to another. It has the general form:

**transfr** from-base-address,offset;to-base-address,offset;length

15 Both *from-base* and *to-base* must be from among the following keywords:

- **routvars, r**

Router variables. This is a special unstructured 256-byte buffer which can be accessed only via **transfr** and **exchang**. The router buffer provides an area for data that is not normally used by lessons. One common use for this buffer is for keeping user

20 performance data for an activity manager.

- **display, d**

CGA screen display memory. Note that display memory for other display types (EGA, VGA, etc.) cannot be accessed with **transfr**.

- **global, g**

Global variables.

- **local,l**

Local variables.

- **sysvars, s**

5           System data area. **CAUTION:** do not use this area for data storage.

- **sysprog,p**

System program area. **CAUTION:** do not use this area for data storage.

- **absolute, a**

Absolute memory location.

10           The following example transfers the router variables into local variables and then displays the student's sign-on name.

```
define local
localr,256
. info,8
15 . name,20
define end
```

```
transfr routvars,0; local, varloc(localr);256
```

20   at       10:5

```
write The student name is «a,name»
```

**exchang**

The **exchang** command is similar to the **transfr** command, but swaps two areas of memory.

25           The following code uses the **exchang** command to swap a pair of 2-byte variables:

```

if x1 < x0
. exchang g,varloc(x0);g,varloc(x1);2
endif

```

This is equivalent to but simpler than the following:

```

5 if x1 < x0
. calc temp ← x0
. x0 ← x1
. x1 ← temp
endif

```

## 10 Accessing Absolute Memory

The **transfr** and **exchang** commands can also be used to access any absolute memory address in the computer. This is accomplished using the base-address keyword **absolute**. The offset is then a four-byte integer location.

A useful function when transferring to or from absolute memory locations is **absloc()**, which returns the absolute location in memory of a variable. This is often used to pass the location of data to a library routine, as follows:

```

pack name;namelen;Wendell Oliver Holmes
library mclib,answer(absloc(name),namelen)

```

The advantage to using **absloc()** here is that unit **mclib,answer** does not need to know whether the data is in the local or global segment--it can copy the data directly from the absolute memory location.

## Technical Notes on Absolute Addresses

The **absloc()** function returns four-byte values over a continuous integer range. To convert an **absloc()** value to the segment:offset form required for passing data to DOS functions, the following calculations can be used:

```

define local

temp ,4

segment ,2

offset ,2

5 define end

calc temp <= absloc(myvar)

 segment <= temp ars 4

10 offset <= temp $mask$ h00f $$ extra 0 required

```

This calculation yields the highest possible segment address and the lowest possible offset address.

The calculation to go from an existing segment:offset address to an absolute integer address is:

```

15 calc segment <= sysloc(global) $$ or local, as appropriate

 offset <= varloc(variable)

 temp <= ((segment $mask$ h0000ffff) $cls4$ 4)+
 (offset$mask$h0000ffff)

```

### Accessing the Memory Pool

20 Data can also be transferred from variables to the TenCORE memory pool, as in:

```
memory write,mempool,moffset,bigbuf,bufsize
```

Where **write** is a keyword specifying the direction of the transfer; "mempool" is the name of the memory pool block; "moffset" is the offset into the memory pool block; "bigbuf" is the variable at which to start the transfer; and "bufsize" is the number of bytes to transfer.



The keyword **write** specifies that the transfer is from variable space to the memory pool; **read** transfers from the memory pool to variable space; and **exchange** swaps the contents of the two.

For more information on this topic or on primary and secondary memory pools, refer to  
 5 the **memory** command.

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## area

**Manages pointer input areas.**

---

|    |                  |                                                     |
|----|------------------|-----------------------------------------------------|
| 10 | <b>area</b>      | keyword;...                                         |
|    | <b>define</b>    | defines a pointer area                              |
|    | <b>highlight</b> | specifies highlight type and color                  |
|    | <b>disable</b>   | temporarily deactivates current pointer areas       |
|    | <b>enable</b>    | reactivates disabled pointer areas                  |
| 15 | <b>clear</b>     | deletes current pointer areas                       |
|    | <b>select</b>    | highlights a pointer area                           |
|    | <b>save</b>      | saves current pointer areas to a named memory block |
|    | <b>restore</b>   | retrieves pointer areas from a named memory block   |
|    | <b>delete</b>    | deletes named pointer area memory blocks            |
| 20 | <b>reset</b>     | deletes all named pointer area memory blocks        |
|    | <b>toggle</b>    | highlights or dehighlights a toggle pointer area    |
|    | <b>inarea</b>    | determines if a location is within a pointer area   |
|    | <b>dir</b>       | returns list of active pointer area identifiers     |
|    | <b>key</b>       | returns the area identifier of a specified key      |

|              |                                                       |
|--------------|-------------------------------------------------------|
| <b>info</b>  | reports the attributes associated with a pointer area |
| <b>repos</b> | repositions all pointer areas in a window             |

---

### Description

Facilitates pointer input within defined areas of the screen. Once a pointer area has been defined, a **Click** or other pointer action within the area generates a specific input value, just as if a keyboard key had been pressed. Appropriate coding can cause such an input to trigger a **flow** branch to another unit, break a **pause**, generate typing at an arrow or any other action desired.

Up to fifty active pointer areas may exist; this number can be increased with the **/sa=** command line option. The number of currently defined pointer areas is stored in the system variable **zareacnt**. **zmaxarea** holds the maximum number of areas allowed.

**area** definitions are cleared upon a **jump** branch to a new main unit. As part of the initializations for a new main unit, the default set of **areas** are activated. **area** definitions are saved when a window is opened and restored to their previous state when the window is closed unless **noarea** is used on the **window close**.

Pointer areas can be highlighted and dehighlighted automatically as the pointer moves in and out of the areas. The current pointer areas, together with their characteristics, can be saved in a named memory block; these can be deactivated and reactivated using the name. Pointer areas can be temporarily disabled and enabled.

**area define; [LOCATION]; [LOCATION]; [action=KEY, action=KEY...]**

Defines a rectangular screen area, whose opposite corners are identified by the two locations, within which any of the pointer actions listed generates an input key. Pointer areas with several defined actions and key values may be continued on following lines.

The following pointer actions can generate input values. Each pointer action has its own keyword:

**click=** any pointer button is pressed

**left=, right=** the left or right pointer button is pressed

**clickup=** any pointer button is released

**leftup=, rightup=** the left or right pointer button is released

5 **add=, sub=** a second button is pressed or released

**enter=, exit=** the pointer enters or leaves an area

If the keyword **left** or **right** is used, then **click** cannot be used. If **leftup** or **rightup** is used, then **clickup** cannot be used. If **click=** is the only action specified, the **click=** keyword can be omitted.

10 *KEY* may be any ordinary key value, such as a,b,c, %f1, etc. or one of the pseudo-keys %input1 - 999.

### Example 1

Inputs the value **%enter** when a button is clicked within the area defined by 10:20; 11:30. In this case the keyword **click=** is optional (**click=%enter**). Coupled with the following **flow** command, the **area** input causes a **jump** to unit *nextunit*.

```
area define; 10:20; 11:30; %enter
flow jump; %enter; nextunit
```

### Example 2

Inputs the value **%L** if the left button is pressed, and **%R** if the right button is pressed.

```
20 area define; 100,200; 300,250; left=L,right=R
```

### Example 3

Inputs the pseudo-key **%input999** when the pointer enters the area defined by 5:3; 6:10. If the left button is released in the area, **%f10** is generated.

```
area define; 5:3; 6:10; leftup=%f10,enter=%input999
```

**Example 4**

Defines the entire screen as a pointer area. Clicking the right button will input the pseudo-key %other.

```
area define; ; ; right=%other
```

5 **Example 5**

Defines a rectangular area from 10:10, 30 characters across for 2 lines. A pointer button click will input the %f1 key.

```
at 10:10
```

```
area define; 30,2; ; click=%f1
```

10 **Example 6**

Defines a rectangular area around the text "Topic 1 : Introduction" allowing for fixed or variable spacing. A click while in the area will input %"1".

```
at 15:10
```

```
write Topic 1: Introduction
```

```
15 area define; 15:10; zx,zy+zfonth; click=%"1"
```

**Example 7**

Is continued over two lines.

```
area define; 200,150; 400,170; left=a,right=%home,leftup=b, rightup=
«h01» ,enter=%input1,exit=%input255
```

```
20 area define; [LOCATION]; [LOCATION]; [action=KEY, action=KEY...] [;modifier;
modifier ...]
```

**Modifiers**

The following modifiers can be used optionally with an **area define** statement. Any number of modifiers may be used and they can be listed in any order. **setid** and **getid** are mutually  
25 exclusive.

**default** preserves the active pointer areas for all subsequent main units. (Normally, a branch to a new main unit that erases the screen clears all pointer areas.) See also **Default Area Highlighting**.

**priority** assigns a priority from 0 to 15 in order to establish a precedence for overlapping areas. Level 15 is the highest priority.

If a priority is not set, the area is assigned a level of 0. If pointer activity occurs within two or more overlapping pointer areas, the highest priority area will take precedence. If overlapping pointer areas have the same level, the last defined area takes precedence.

**getid** specifies a variable to hold the unique 2-byte pointer area identifier that is automatically generated by the system when a pointer area is defined. System generated identifiers are always negative, between -32,768 and -1. The ID is used to identify a specific area in forms of the area command and is returned in system variable **zinputa**.

**setid** specifies a number which becomes the pointer area's unique identifier. Author-specified identifiers must be between 1 and 32,767 to avoid a possible conflict with system-generated identifiers. The definition of a pointer area whose identifier is identical to that of an existing pointer area will result in the existing pointer area being redefined. The ID is used to identify a specific area in forms of the area command and is returned in the system variable **zinputa**.

### Example 1

The pointer area definition will be a **default** area upon entering a new main unit. The area can be referenced later using the ID received in the variable *areaID*.

```
area define; 5:10; 10:25; left=b,right=B; default; getid,areaID
```

**Example 2**

Inputs the pseudo-key %input1 when either button is pressed while in the rectangular area. The area can be referenced by the specified ID value 1.

```
area define; 100,100; 200,110; %input1; setid,1
```

5 **Example 3**

Inputs the hexadecimal value 7000 when the pointer enters the rectangular area. If any other pointer area with a lower priority level overlaps this area, then this one takes precedence because it has the maximum priority level.

```
area define; 400,150; 450,200; enter= «h7000» ; priority,15
```

10 **area highlight: COLOR | off [; xor] [track | toggle]**

Controls the highlighting color of all subsequent pointer areas. Area highlighting is off by default. A single **area highlight** statement affects all subsequent **area define** statements, but not pointer areas defined previously. Highlighting is reset to **off** by an **initial** statement.

The system variable **zareahl** holds the area id of the currently highlighted area (or 0 if no  
15 area is highlighted).

Highlighting to the given color is produced by plotting a box in an exclusive-or (XOR) mode and color over the screen area. The upper-left pixel of the screen area is used in determining the box color that will XOR the screen to the desired highlight color.

**Modifiers**

20 The following modifiers can be used optionally with an **area highlight** statement but only when a color is specified. **track** and **toggle** are mutually exclusive.

**xor** specifies that pointer areas are to be highlighted by directly XORing the screen with the color specified



- track** dehighlights the area only when the pointer enters another area that has highlighting enabled
- toggle** disables automatic area highlighting and allows author-controlled highlighting (See **area toggle**.)

## 5 **Default Area Highlighting**

When default areas are in effect and a main unit is entered via a **jump** - type branch, area highlighting does not occur until after one of the following events:

- a branching command is executed (**loop**, **jump**, **jumpop**, **branch**, **doto**, **goto**)
- input is requested from the system (**pause**, **arrow**, **nextkey**, **delay**)
- 10 • the end-of-unit is reached
- certain commands that may have a long execution time are executed (**image**, **fill**)
- An **enable** command with the keyword **area**, **pointer** or **break**

These are the same points at which the pointer position is checked to see whether it has just entered or exited a highlighted area.

- 15 This delay allows the author time to get the display on the screen for which highlighting is desired. If a branch is required or if input must be requested before building the screen, the author must first issue a **disable area** statement to disable highlighting. After building the screen, **enable area** turns on any highlight.

### **Example 1**

- 20 Produces red+ highlight areas. It uses the upper left corner of the area as an XOR reference color. Thus, the color of the pixel at 250,320 (the upper left corner of the area) is used to determine what color to XOR the area with to produce red+.

```
area highlight; red+
area define; 250,300; 400,320; click=%f10
```

**Example 2**

Turns off highlighting for all subsequently defined pointer areas.

```
area highlight; off
```

**Example 3**

5 XORs subsequently defined pointer areas with blue. The areas will be highlighted when the pointer enters an area but will not be dehighlighted until it enters another area.

```
area highlight; blue; xor; track
```

**Example 4**

Disables automatic area highlighting. **area toggle** can be used to highlight these areas.

10 

```
area highlight; white; toggle
```

```
area disable [; areaID/s] [; noplot]
```

Temporarily disables the pointer areas having the identifiers specified. The **disable** keyword alone temporarily disables all defined areas. A disabled pointer area no longer produces pointer input or a highlight. If a pointer area is highlighted when disabled, highlighting is turned

15 off unless the **noplot** modifier is present.

**Example 1**

Disables the pointer area whose identifier is contained in the variable *idvar*. If the pointer area is currently highlighted, it will remain highlighted.

```
area disable; idvar; noplot
```

20 **Example 2**

Disables the pointer areas whose identifiers are 1 and 2.

```
area disable; 1,2
```

**Example 3**

Temporarily disables all pointer areas.

25 

```
area enable
```

**area enable** [**;** **areaID/s**]

Enables pointer areas previously disabled with **area disable**.

#### Example 1

Enables the pointer areas whose identifiers are contained in the array elements **areaID(1)**,

5 **areaID(2)**, and **areaID(3)**.

**area enable; areaID(1), areaID(2), areaID(3)**

#### Example 2

Enables all pointer areas

**area enable**

10 **area clear** [**;** [**areaID/s**][**;** **noplot**] [**;** **default**]]

When used with area identifiers, **clear** removes the specified pointer. When used without area identifiers, **clear** removes all areas. Areas are cleared regardless of being disabled.

If a pointer area is highlighted when it is cleared, the highlighting will be turned off unless **noplot** is used.

15 The **default** modifier is used to remove any area definitions that have been set with the **default** modifier.

#### Example 1

Deletes the pointer areas whose identifiers are contained in variables *ID1* and *ID2*

**area clear; ID1, ID2**

20 **Example 2**

Deletes all pointer areas. A following **jump** branch will restore any unit **default** pointer areas.

**area clear**

**Example 3**

Deletes all pointer areas from the entire screen, leaving any highlight on. When the window is closed, any previous areas are restored.

```
window open; 100,100; 300,300
```

```
5 area clear; ;noplot
```

```
...
```

```
window close
```

```
area select; arealD | pointer | off
```

Highlights the area specified by the identifier or currently under the pointer. If **off** is specified, any highlighted area is turned off. **select** does not work with **toggle** highlight areas.

Only one area is highlighted at a time; any previously highlighted area is turned off.

**Example 1**

Highlights the area whose identifier is contained in the variable *aID*.

```
area select; aID
```

15      **Example 2**

Turns off any highlighted area.

```
area select; off
```

**Example 3**

Before opening the window, all areas are disabled. This turns off any highlight that is on.

20      After closing the window, the areas are re-enabled and any area under the pointer is highlighted.

```
area disable $$ turn off areas and highlight
```

```
window open, 100,.100;300,300
```

```
...
```

```
window close
```

```
25 area enable $$ turn areas on again
```

```
area select;pointer $$ highlight if pointer on area
```

**area save; 'NAME' | local**

**area save; default**

Saves the current set of area definitions in a memory pool block or the **default** buffer. The name can be either a text literal or contained in a variable. Named blocks can be restored later in any unit.

The **local** keyword saves the area settings in a memory pool block specific to the current unit. A local block can be restored only in the unit which saved it; it is deleted automatically when execution of the unit ends.

Saving the current area settings to the **default** buffer makes them the default **area** settings for all new main units. They are automatically reset on a **jump** to another unit.

The memory pool is used by the commands: **memory, image, window, status, area, flow, font** and **perm**. Memory blocks are tagged as belonging to a specific command type at creation and cannot be accessed by other commands using the memory pool; different commands can use the same name for a memory block without conflict.

### Example 1

Saves the current pointer areas in the named memory block *level1*

**area save; 'level1'**

### Example 2

Saves the current pointer areas using the name contained in the variable *areavar*.

**area save; areavar**

### Example 3

Saves and restores the active flow settings over a subroutine call in a memory pool block unique to the executing unit. The block is automatically deleted when the unit is exited.

**area save; local**

```
do routines, graph
area restore; local
```

#### Example 4

Makes the current area settings the defaults for all subsequent units that are entered by a  
 5 jump branch.

```
area save; default
area restore: 'NAME' | local [; delete] [; noplot]
area restore; default [; noplot]
```

Replaces the current area settings with a previously saved set. Optionally, the named or  
 10 local block can be deleted from the memory pool by using the **delete** modifier.

Any areas highlighted when saved are highlighted when restored unless the **noplot** modifier is used.

#### Example 1

Saves and restores the current area settings over a library call. The library routine can  
 15 alter the active area settings as desired without affecting the calling program upon return.  
 Alternately, the **area save** and **restore** could be built into the library routine to provide a more easily used tool.

```
area save; 'areas'
library routines, graph
20 area restore; 'areas'
```

#### Example 2

Saves and restores the active flow settings over a subroutine call in a memory pool block unique to the executing unit. The block is automatically deleted when the unit is exited. The highlight status is not restored.

```
25 area save; local
```

```
do routines, graph
area restore; local; noplot
```

### Example 3

Restores the unit default set of pointer areas.

```
5 area restore; default
area delete; 'NAME' local
```

Deletes a saved set of pointer areas from the memory pool without affecting any current pointer area definitions.

### Example

10 Deletes from memory the areas saved under the name *menu*.

```
area delete; 'menu'
area reset
```

Deletes all named sets of pointer areas from the memory pool without affecting current definitions. The **default** set of area settings are unaffected.

```
15 area toggle; arealD
```

Highlights or dehighlights the pointer area whose identifier is specified. This keyword option only operates on **toggle** pointer areas (as set by **area highlight**) It is intended for authors who want total control over the highlighting of pointer areas. Unlike **area select**, more than one pointer area can be highlighted.

20 **Example**

Highlights the pointer area whose identifier is contained in the variable *cID*.

```
area toggle; cID
```

**area inarea: LOCATION; arealD**

Determines whether the specified location is within a pointer area. If so, the area's identifier is put into the variable *arealD*. If the location is within multiple areas, the highest priority area or, if levels are the same, the last defined area takes precedence.

5 If the location is not within any area, the variable is set to 0.

**Example**

Sets *whichID* to 1, the identifier belonging to the priority 15 pointer area.

```
area define; 90,100; 120,160; click=%space;
 priority, 15; setid,1
10 area define; 90,100; 120,160; click=%home;
 priority, 6; setid, 2
```

...

```
area inarea; 100,155; whichID
```

```
area dir; idBuffer [;length]
```

15 Returns the identifiers of all active pointer areas. To report on the maximum number of pointer areas, the area identifier buffer should be **zmaxarea\*2** bytes in length.

**Example**

Returns the area identifiers of all currently active pointer areas in the array buffer *id*.

```
define local
20 id(50),2 $$ use system default for array length
define end
```

...

```
area dir; id(1); 2*zareacnt
```

```
area key; KEY; arealD
```

25 Returns the identifier of the pointer area which includes the specified key in its pointer action list. If two areas have the specified key listed, then the identifier of the highest priority area



is returned. If the areas have equal priority, then the identifier of the last defined pointer area is returned.

**area info; arealD; infoBuffer48**

Returns the attributes of an enabled pointer area into the buffer specified. The pointer area

5 is selected by providing its identifier. The structure of the 48-byte buffer is as follows:

| Attribute                               | Bytes |
|-----------------------------------------|-------|
| lower left x coordinate                 | 2     |
| lower left y coordinate                 | 2     |
| upper right x coordinate                | 2     |
| upper right y coordinate                | 2     |
| highlight color of area                 | 4     |
| type (0=none; 1=highlight; 2=track)     | 1     |
| priority (0=none; 1..15=priority level) | 1     |
| default (0=none; 1=default)             | 1     |
| window open level ( <b>zwindows</b> )   | 1     |
| reserved                                | 16    |
| <b>left</b> = key value                 | 2     |
| <b>right</b> = key value                | 2     |
| <b>enter</b> = key value                | 2     |
| <b>exit</b> = key value                 | 2     |
| <b>lcftup</b> = key value               | 2     |
| <b>rightup</b> = key value              | 2     |
| <b>add</b> = key value                  | 2     |
| <b>sub</b> = key value                  | 2     |

### Example

Reads the information from the area whose identifier is contained in the variable *ID2*, into the buffer named *areadata*.

**area info; ID2; areadata**

10 If a window is in effect when this statement is executed, the specified coordinates will be relative to the current window.

**area repos; xOffset,yOffset**

Adjusts all pointer areas by the absolute screen dimensions specified. If one or more windows are open, it operates only on areas created while the current window was open.

**Example**

Moves all pointer areas to the left 20 pixels and up 100 pixels.

```
area repos; -20,100
```

**System Variables**5      **zreturn**

The **save**, **restore**, **reset** and **delete** forms of the **area** command, which use the memory pool, report on success or failure in **zreturn**. In addition, the **select** and **toggle** forms also report error conditions through **zreturn**. All other forms set **zreturn** to ok (-1). The major **zreturn** values are:

|    |                      |                                                                                                         |
|----|----------------------|---------------------------------------------------------------------------------------------------------|
| 10 | -2                   | Redundant operation; area is already selected                                                           |
|    | -1                   | Operation successful                                                                                    |
|    | 10                   | Name not found                                                                                          |
|    | 11                   | Select or toggle of invalid highlight type                                                              |
|    | 18                   | Unable to fill memory pool request                                                                      |
| 15 | <b>Miscellaneous</b> |                                                                                                         |
|    | <b>zareacnt</b>      | Number of currently defined pointer areas                                                               |
|    | <b>zareahl</b>       | <b>area</b> id of currently highlighted area (else 0)                                                   |
|    | <b>zinputa</b>       | <b>area</b> id of area causing the current <b>zinput</b> value (else 0), set when <b>zinput</b> updated |
| 20 | <b>zmaxarea</b>      | Maximum number of areas that can be defined                                                             |

**asmcall**

**Calls an assembly language routine loaded into variables.**

---

```
asmcall buffer [,variable]
```

buffer      starting variable where routine is loaded

5      variable      puts offset of specified variable into register BX

---

**Description**

Calls an assembly language routine which has been loaded into local or global variables. Segment register DS points to the start of variables. if the optional *variable* is used, register BX is set to the offset of *variable*. The result is that DS:[BX] points to the variable listed as the

10      second tag. A far *return* must be executed at the end of the routine to return control to TenCORE. The value of the AL register is returned in the TenCORE system variable **zreturn**.

The assembly language routine may alter any of the microprocessor registers, but SS and SP, if changed, must be restored to original values before returning to TenCORE.

**Addresses**

15      The following system-defined function references are sometimes useful with **asmcall**:

**sysloc(global)**      Segment address of global variables

**sysloc(local)**      Segment address of the current unit's local variables

**varloc(variable)**      Offset address of *variable*

**absloc(variable)**      Absolute location of *variable* within memory, expressed as a 4-byte offset

20      with no segment. This corresponds to the segment:offset address as follows:

segment = **absloc()** Sars\$ 4

offset = absloc() Smask\$ h0f

If you have the segment and offset and wish to convert to the absolute location, use the following calculation:

absloc = ((segment Smask\$ h0000ffff) Shls4\$ 4) + (offset Smask\$ h0000ffff)

## 5 Example

Reverses the bits in a byte.

```

*
define global
asmbuff(12),1 $$ buffer for assembly language program
10 asmdata ,1 $$ integer byte to reverse
define end
*
* Load short assembly language routine by direct execution.
*
15 * The routine begins with DS:BX pointing to the TenCORE
* variable "asmdata". The program loads and reverses
* the byte, leaving it in register AL. After the asmcall,
* zreturn is set to the value left in AL.
*
20 * The set command used here allows the programmer to
* emulate the structure that would be used for assembler
* programming.
*
set asmbuff(1) $$ mirror proc far
25 h8a, h27 $$ mov ah, [bx] ; fetch byte
 h0b9, h08, h00 $$ mov cx,0008 ; shift 8 bits
*

```

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```

* $$ mirrori:
 h0d0, h0ec $$ sh rah,01 ; move LSB to CF
 h0d0, hd0 $$ rcl al,01 ; shift CF into AL
 h0e2, h0fa $$ loop mirrorl
5 *
 h0cb $$ retf ; far return
*
 $$ endp
*
calc asmdata <= h55 $$ trial value to demonstate bit reversal
10
asmcall asmbuff(1), asmdata $$ call routine, pointing to data
at 4:4
write Original value = «h,asmdata» hex
 Reversed value = «h,zreturn» hex

```

## 15 System Variable

**zreturn**            Holds the value of AL register upon return

## at/atf

Sets the screen location and text margins.

---

```
at [LOCATION] [, LOCATION]
```

---

## 20 Description

Sets the current screen x-y location and the left text margin to the first *LOCATION* in the tag. The system variables **zx**, **zy** and **zmargin** are updated to this new location. If character coordinates are used to specify the **at** location, the **zx** and **zy** system variables contain the lower left graphic coordinates of the character cell.

A right text margin (which is initially set to the right screen or window border) can be set by specifying a second *LOCATION*. The right margin is found in the system variable **zrmargin**. Text that hits the right margin is automatically wrapped to the left margin. See **text margin** for the available text wrapping options. The right margin is ignored by the obsolete **charset** character plotting.)

The blank-tag form sets the left margin to the current screen location. This form is equivalent to the following statement:

```
at zx,zy
```

The **atf** form of the command allows for the automatic adjustment of the **zy** position based on the height of the first following real plotting character. The top pixel of this first following real character is placed at the same y-position as the top of a standard font character. This action of **atf** provides for an apparent fixed top margin for text even if the text contains unknown starting embedded text attributes such as size and font. The adjustment to **zy** occurs in the following **write** or **show** statement when the first real character is plotted on the screen.

## Examples

### Example 1

Writes text starting at x = 10, y = 150.

```
at 10,150
write This is line one of my text.
 This is line two at the same left margin.
```

### Example 2

Writes text starting at line 7, character 3.

```
at 7:3
write The line:character format is used for text more often than the
 graphic x,y format.
```

**Example 3**

The **text margin** statement with **wordwrap** sets plotting to perform automatic wrapping of words at the right text margin stated in the following two location **at**. The second location on the **at** sets up a right margin at the 30th character position on the screen (or current window).

- 5 The line number part of the second location is not used by the system plotter.

```
text margin;wordwrap
at 5:10; 20:30

write This text will appear on the screen as a paragraph only 20
characters wide regardless of how long the lines look in source code...
```

10 **Example 4**

By using **atf** commands, the top of the text from the two **write** statements appear to have a common top margin on the screen. The second **write** statement that has an initial embedded size 2 code sequence adjusts the system variable **zy** upon plotting the "S" so that the top of the "S" appears in the same location as the standard size font.

```
15 atf 10:10
write Size 1 text
atf 10:30
write Size 2 text

* $$ Embedded size 2 at start of text
```

20 **System Variables**

The following system variables reflect the actions of the **at** statement:

|                  |                                 |
|------------------|---------------------------------|
| <b>zx</b>        | X-coordinate of screen location |
| <b>zy</b>        | Y-coordinate of screen location |
| <b>zline</b>     | Line number                     |
| 25 <b>zspace</b> | Character number                |

|                 |                                       |
|-----------------|---------------------------------------|
| <b>zxycolor</b> | Color of the pixel at screen location |
| <b>zmargin</b>  | Left text margin                      |
| <b>zrmargin</b> | Right text margin                     |

## beep

5           **Causes the speaker to generate a controlled beep.**

---

**beep**    duration [, hertz ]

          duration    the length of beep, in seconds

          hertz        frequency in cycles per second

---

### Description

10           Produces a tone of the frequency and length specified in the tag. If the frequency is not specified, it defaults to 1000 Hz.

### Examples

#### Example 1

          Produces a small, perhaps recognizable musical tune.

|    |      |            |        |
|----|------|------------|--------|
| 15 | beep | .15, 261.3 | \$\$ C |
|    | beep | .2, 349.66 | \$\$ F |
|    | beep | .2, 440.88 | \$\$ A |
|    | beep | .4, 523.25 | \$\$ C |
|    | beep | .2, 440.88 | \$\$ A |
| 20 | beep | .4, 523.25 | \$\$ C |

#### Example 2

          Demonstrates user control of a **beep** command.



```

define local
length ,4,r $$ length of beep
define end
*
5 at 5:5
write How many seconds do you want the speaker to beep?
arrow 6:5
store length
. at 8:7
10 . write Please enter a number, like 2,3 or 5
ok
. beep length
endarrow

```

### Frequencies

15           A one-octave scale from middle-C has the following frequencies. Multiply or divide by two for other octaves:

|    |    |        |
|----|----|--------|
|    | C  | 261.63 |
|    | C# | 277.18 |
|    | D  | 293.66 |
| 20 | D# | 311.13 |
|    | E  | 329.63 |
|    | F  | 349.23 |
|    | F# | 369.99 |
|    | G  | 392.00 |
| 25 | G# | 415.30 |
|    | A  | 440.00 |

|    |        |
|----|--------|
| A# | 466.16 |
| B  | 493.88 |
| C  | 523.25 |

To calculate more precise frequencies, use a multiple of 110 as a standard "A" and  
 5 multiply by the twelfth root of 2 for each half-tone increment.

## block

---

block [LOCATION ] ;[LOCATION ] ;[LOCATION ] [;[from page][,to page]]

---

### Description

Copies a rectangular screen area from one location to another including across display  
 10 pages. Operational only on 16- and 256-color screens. The block command works solely with  
 absolute plotting coordinates; it is not affected by origin, rotate, or scale.

The first two locations specify the corners of the source area to be copied; if not specified  
 they default to the entire screen. The third location is the upper-left corner of the destination; it  
 defaults to the same position as the source area.

15 The fourth argument (frompage) is the source page number; it defaults to the current read  
 page (zrpage).

The last argument (topage) is the destination page number; it defaults to the current write  
 page (zwpage)

```

block x1,y1; x2,y2; x3,y3 $$ copy one area of screen to another
20 block x1,y1; x2,y2;; 2,1 $$ copy from page 2 to page 1
block x1,y1; x2,y2;; 2 $$ copy from page 2 to current page
at 10:10
block 6,5;;5:10 $$ copy 6 chars,5 lines from 10:10 to 5:10

```

**box**

**Draws a solid box or a frame on the screen.**

---

```
box [LOCATION] [; [LOCATION] [; Xframe [, Yframe]]]
```

---

**Description**

- 5            Draws a solid box or frame on the screen in the foreground color. See the Command Syntax Conventions for a description of *LOCATION*. The **erase** command is identical to **box** except that it uses the background color for drawing.

            The presence of a frame width argument signifies that a frame rather than solid box be drawn. The widths of the right and left sides are specified in pixels by the first frame argument  
 10        while the second frame argument specifies the top and bottom widths. If the second frame argument is absent, the top and bottom frame width is set to best match the side width in aspect appearance on the screen.

**Examples****Example 1**

- 15            The entire screen (or window) is made blue with a white frame 5 pixels wide.

```
color blue
box
color white+
box ;;5
```

20            **Example 2**

            A solid rectangle 200 pixels wide by 100 pixels high is put on the screen in the foreground color. Graphic coordinates are used to specify each x,y coordinate for a location.

```
box 101,101; 300,200
```

**Example 3**

The text in the **write** statement is given a red frame 2 pixels wide. The **text measure** command is used to determine the screen area that a following paragraph of text plots over on the screen. This information is returned in the system variables **zplotxl**, **zplotyl** for lower left corner and **zplotxh**, **zplotyh** for upper right corner.

```

text measure $$ initialize text measuring
*
at 100,150
write This is a paragraph of text of arbitrary
10 length that will be nicely framed...
*
color red+
box zplotxl-2,zplotyl-2;zplotxh+2, zplotyh+2; 2
 $$ frame the text

```

**Example 4**

A blue box 20 characters wide and 10 lines deep is put on the screen starting on the 10th line. Since the **box** command does not change the system variables **zx** and **zy** as set by the **at** command, the text will also occur at the start of line 10.

```

at 10:1
20 color blue
box 20,10
color white+
write This text appears in the box...

```

## branch

Transfers execution to a labeled point in the same unit.

---

**branch** label | **q**

**branch** *SELECTOR*; label | **q**; label | **q**...

- |   |          |                                                                                                                                                      |
|---|----------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5 | label    | Any valid label present in the current unit. A label is a numeral optionally followed by 1 to 7 letters or numerals, in the command field of a line. |
|   | <b>q</b> | Branch to the end of the current unit.                                                                                                               |
- 

### Description

- 10 Alters the flow of execution within a unit, by transferring execution to the line following the specified label, or to the end of the unit if the keyword **q** is specified. A blank entry in the selective list is used to fall through to the following command.

### Example

If *name* is already set, the **branch** command will skip the arrow structure.

```

15 branch name=0 ; ;1skip
 at 10:10
 write Enter your name.
 long 8
 arrow 11:10
20 storea name
 ok
 endarrow
 *
 1skip

```

```

at 15:10
write Welcome, «showa,name».

```

## calc

Assigns a value or calculation to a variable.

---

```

5 calc variable \Leftarrow expression

```

---

### Description

The expression to the right of the assignment arrow can be any combination of constants, literals, variables, operators and functions so long as it evaluates to a single numeric value.

**calc** cannot work with variables greater than 8 bytes in size.

10 The command name does not need to be repeated for additional lines of calculations.

For more information on calculations, assignments, and variables, refer to the section **Variables, Calculations, and Data Transfer** in this document.

### Example

Increment a counter, compute a percentage, and evaluate a complex expression.

```

15 calc count \Leftarrow count + 1

 score \Leftarrow correct / total

 dist \Leftarrow (1/2) * g * (t**2)

```

## calcc

Selectively performs an entire calculation and assignment.

---

```

20 calcc SELECTOR; var1 \Leftarrow exp1; var2 \Leftarrow exp2;;...

```

---

## Description

**calcc** is a selective form of **calc** that performs one of a list of calculations, based on the value of the selector. Each calculation in the list can assign a different value to a different variable. if no calculation is to be performed for a particular value of the selector, a null tag (;) is used.

The **calcc** statement can be continued in the tag field of subsequent lines.

## Examples

### Example 1

*review* is set if the selector *right* is 1; *score* is assigned if *right* is 2 or greater. Nothing occurs for a zero or negative value of *right*.

```
calcc right;;; review ← -1; score ← (right/5)*100
```

### Example 2

The value 4 is assigned to *section* if the selector *complete* is true; if false, no assignment occurs.

```
15 calcc complete; section ← 4;;
```

### Example 3

*column* is assigned if *select* is 1, *apples* is assigned if *select* is 2, and *total* is assigned 50 if *select* is 3. Nothing occurs if *select* is negative, zero or greater than 3.

```
calcc select,,,
20 column ← 22 + pointer;
 apples ← bushels*47
 total ← 50;;
```

**calcs**

Selectively assigns a value to a variable.

---

**calcs**    *SELECTOR*; variable  $\Leftarrow$  exp1; exp2;;...

---

**Description**

5            **calcs** is a selective form of **calc** that evaluates one of a list of expressions and assigns it to a given variable. Based on the value of the selector, an expression is selected and evaluated from the list on the right of the assignment arrow and assigned to the specified variable. If no assignment is to be performed for a particular value of the selector, a null tag (;) is used; the variable remains unchanged.

10           The **calcs** statement can be continued in the tag field of subsequent lines.

**Examples****Example 1**

The selector *month* is used to set the variable *days* to its proper value. The selective assignment is continued over two lines.

15    **calcs**    *month*; *days*  $\Leftarrow$  ;;31;28;31;30;31;30;  
                   31;31;30;31;30;31

**Example 2**

If *complete* is true, *section* is assigned the value 4; otherwise it is set to the evaluation of the expression *last\*2*

20    **calcs**    *complete*; *section*  $\Leftarrow$  4;*last\*2*



**circle**

**Draws a circle.**

---

**circle** radius [ ,**fill** | angle ,angle2 ]

---

**Description**

5           Draws a circle of the specified radius with its center at the current screen location in the current foreground color.

The optional **fill** keyword produces a solid circle filled with the current foreground color.

The current screen location is not altered after a one-tag **circle**, so concentric circles can be drawn without resetting the screen location.

10           The three-tag form draws an arc. Arcs are always drawn counter-clockwise from *angle1* to *angle2*. As a result, different arcs are drawn depending on which angle is specified first. For example, **circle 100,0,90** draws a quarter of a circle, from 0 to 90 degrees. The statement **circle 100,90,0** draws three-quarters of a circle, from 90 degrees around to 360 (or 0) degrees.

For an arc, the current screen location is updated to the ending (last) arc position.

15           **Example**

Draws a circle centered on the screen; two arcs with the same center but different radii; then a filled circle.

```

screen vga,graphics,medium,color
at 320,240 $$ set the center of the circle
20 circle 80 $$ draw a circle with radius 80
circle 60,0,90 $$ draw a quarter of a circle
at 320,240 $$ reset the center of the circle
circle 70,90,0 $$ draw three-quarters of a circle

```

```

at 320,240 $$ reset the center of the circle
circle 40,fill $$ draw a filled circle in the center

```

## clearu

Removes unit(s) from the unit cache.

---

```

5 clearu [UNIT]

clearu SELECTOR; UNIT; UNIT;...

```

---

### Description

Units are automatically loaded into a virtual memory central unit cache as they are needed, and deleted as necessary to make room for new units. **clearu** can be used to manually

10 clear specific units from the unit cache.

The blank-tag form removes all but the current unit from the unit cache.

**clearu** clears only units loaded from a file of the type corresponding to the current mode of operation. See **operate** for a discussion of modes of operation.

**clearu** is affected by the **edisk** command. Because multiple copies of a single file may be  
 15 present on different drives, there may be multiple copies of a single unit in the unit cache. If **zedisk** = -1, units are fetched by searching all drives. All units matching the lesson/unit specification in the tag of **clearu**, and matching the current mode of operation (source or binary) are cleared from the unit cache. if **zedisk** ≠ -1, then only a unit from the current execution disk is cleared from the unit cache.

20 If no unit is cleared from the unit cache because no unit matched the unit reference and mode of operation specifications, **zreturn** is set to -2. If an attempt is made to explicitly clear the currently executing unit, **zreturn** is set to 19.

**clearu** is primarily used by utility programs to control which version of a unit is in memory or to control which units are deleted to make room for others.

### System Variables

#### zreturn

|   |    |                                                    |
|---|----|----------------------------------------------------|
| 5 | -2 | Redundant operation; no action taken               |
|   | -1 | Operation successful                               |
|   | 19 | Operation invalid, tried to clear the current unit |

### clock

Reads or writes system clock.

---

10 **clock** time4 [ ,set ]

---

#### Description

Copies the information from the system clock into the specified 4-byte buffer. The **set** keyword sets the system clock to the time in the buffer.

The system clock is stored as 4 bytes; one byte each for the hour, minute, second, and  
 15 hundredths of a second.

#### Example

Reads the system clock and displays the current time in hours and minutes.

```

define local
sysclock, 4 $$ variables to hold time
20 . hours,1
 . minutes,1
 . seconds,1
 . hundrths,1

```

```

define end
*
clock sysclock $$ read the current time
at 5:5
5 write The current time is: «t, hours,2»:«t, minutes,2»)

```

## color

Sets the foreground color.

---

|    |              |                                   |
|----|--------------|-----------------------------------|
|    | <b>color</b> | <i>COLOR</i>                      |
| 10 | <b>color</b> | <i>SELECTOR; COLOR; COLOR;...</i> |
|    | <b>write</b> | <i>«color   c, COLOR»</i>         |

---

### Description

Selects the foreground color for subsequent text and graphics.

The + at the end of a keyword indicates the bright version of the color. The keyword

15 **backgnd** gives the background color (last specified with the **colore** command). A numeric expression evaluating to a hardware color number may be used in place of a keyword.

Keywords set the first 16 colors (see the Command Syntax Description for keyword Colors). A color number must be used for colors coded higher than 15.

The default foreground color is **white**. The default can be changed using **color** followed

20 by **status save; default**.

The color of text can also be changed by embedding text attributes into the tag of a **write** command.

### CGA Restrictions

When using any of the CGA graphics displays on a composite color monitor, turning the thickness option on (**thick on**) produces truer colors.

**screen**                    cga, graphics, medium, color

5        **screen**                    cga, graphics, medium, mono

When using **screen cga,graphics,medium**, four separate groups of colors are available:

| 1       | 2       | 3       | 4        |
|---------|---------|---------|----------|
| backgnd | backgnd | backgnd | backgnd  |
| green   | green+  | cyan    | cyan+    |
| red     | red+    | magenta | magenta+ |
| brown   | brown+  | white   | white+   |

All colors on the display must be from one color group. If a color from one group is selected while colors from another group are on the display, all colors on the screen change to the corresponding color in the newly selected group.

### Example

Displays yellow text in a blue box.

**screen**    vga

**color**     blue

15    **box**        5:10;10:50

**color**     yellow

**at**         6:15;10:50

**write**     A paragraph of yellow text...

### System Variables

20        **zcolor**                    Color number if set by a color keyword name; -1 if set by a color number

**zhcolor**                    Hardware color number

**colore**

Sets the erase color.

---

**colore** *COLOR*

**colore** *SELECTOR; COLOR; COLOR;...*

5 **write** «**colore** | *ce, COLOR*»

---

**Description**

Sets the erase color to be used for erasing, including: mode erase plotting, full screen erases, the **erase** command, and character background plotting in **mode rewrite**. To fill the screen or window with the erase color, a full-screen erase must be performed after execution of

10 **colore.**

The color keywords set the first 16 colors (See the Command Syntax Conventions). A color number must be used for colors coded higher than 15.

A numeric expression evaluating to a hardware color number may be used in place of a keyword.

15 On CGA graphics displays, **colore** is subject to the same color restrictions as **color**. See the **color** command description for details. On CGA text displays, bright colors (8-15) are not available for **colore**.

The default erase color is **black**. This default can be changed using **colore** followed by **status save; default**.

20 **Example**

Erases the screen to blue after [ENTER] is pressed.

**screen** *vga*

**color** *white+*

```

at 5:5
write Press Enter to see the background color change.
colore blue
pause pass= %enter
5 erase
at 5:5
write The screen has been erased to change the
 background color.

```

### System Variables

|    |                                                                                                                                   |
|----|-----------------------------------------------------------------------------------------------------------------------------------|
| 10 | <b>zcolore</b> Color number if set by a color keyword; -1 if set by a color number<br><b>zhcolore</b> Hardware erase color number |
|----|-----------------------------------------------------------------------------------------------------------------------------------|

## compare

Compares two text strings.

---

**compare** string1, string2, length, result

---

|    |                                                                                                                                                                                                                                                               |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15 | string1 the reference string, typically a variable or an up to 8-byte left-justified literal.<br>string2 the compare string, must be in a variable.<br>length number of bytes to compare<br>result-1 = identical; 0 = no match; >0 = last matching character. |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

---

### Description

|    |                                                                                                                                                                                                                                                                  |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 20 | Compares two strings byte-for-byte. Variable boundaries can be crossed. The value returned into <i>result</i> indicates the success of the <b>compare</b> . If the strings partially match, <i>result</i> is set to the position of the last matching character. |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

In addition to *result*, **compare** sets **zreturn** to -1 if the strings match. If the strings do not match, **zreturn** is set to indicate which string is "alphabetically" less than the other: 0 if the first is less, 1 if the second is less. The ASCII codes for the first characters that do not match will be compared to determine which string is "numerically" less. For instance, if "aaa" and "aab" are compared, **zreturn** will be set to 0 because the third character "a" of the first string is less than the third character "b" of the second string.

System variables can not be used for either string.

### Example

Checks a "password" before letting the user continue

```

10 define local
 input ,8 $$ the user's entry
 password = 'saturday' $$ today's password
 return ,2 $$ value returned by compare
 define end
15 *
 at 3:2
 write Enter the password of the day...
 long 8
 arrow 4:2
20 zero input
 storea input
 compare password, input,8,return
 ok return
 . write Good. Let's continue
25 no
 . write Sorry, wrong password. Erase and try again.
 endarrow

```



**System Variables****zreturn**

|   |    |                              |
|---|----|------------------------------|
|   | -1 | First string = second string |
|   | 0  | First string < second string |
| 5 | 1  | Second string > first string |

**compute**

**Computes the numeric value of a string of characters.**

---

**compute** string, length, result

|    |        |                                                                 |
|----|--------|-----------------------------------------------------------------|
|    | string | text variable containing the characters to numerically evaluate |
| 10 | length | the number of characters to evaluate                            |
|    | result | numeric variable to hold the result of the compute              |

---

**Description**

Converts a string into a numeric value. The string may contain leading or trailing blanks, a leading + or - sign, and a decimal point. The string cannot contain any other operators. If the conversion is successful, the value is stored in *result*. If **compute** fails (**zreturn** = 0), *result* remains unchanged.

**Example**

Converts a string to a numeric value, performs an operation on the value, then converts it back to a string:

```

20 define local
 string, 10 $$ holds the string to convert
 length ,2 $$ length of the string
 number ,4,r $$ real number for result

```

```

define end
*
pack string; length ;23.65
compute string, length, number $$ convert to numeric
5 calc number ← number * 4.83
packz string;;«show, number» $$ convert to string
at 5:5
write The new string is:«showa, string »

```

### System Variables

10    **zreturn**

|    |                                                                                                                        |
|----|------------------------------------------------------------------------------------------------------------------------|
| -1 | Operation successful                                                                                                   |
| 0  | No valid number was found in the string                                                                                |
| 1  | Overflow error trying to store the converted number in the result variable.<br>The result variable needs to be larger. |

### 15    **date**

Reads or sets the current date.

---

**date**    date4 [ ,set ]

---

#### Description

Reads the date from the system clock and puts it in a variable. If the **set** keyword is used,  
20    the system date is set to the date stored in the variable.

The system date is stored as 4 bytes; 2 bytes for year, 1 byte for month, 1 byte for day.

#### Example

Displays the current date.

```

define local
today,4
. year, 2, integer
. month, 1, integer
5 . day, 1, integer
define end
*
date today
*
10 at 10:10
write Today is $$$
writec month;;;January ;February ;March ;April ;May ;June ;
 July ;August ;September ;October ;November ;December ;
write «show,day», «show,year».

```

## 15 debug

Turns step-by-step program execution on/off.

---

|       |                                   |
|-------|-----------------------------------|
| debug | on   off                          |
| debug | SELECTOR; on   off ; on   off;... |

---

### Description

20        **debug on** stops execution of the current unit and enters the debugger. From the debugger, execution may continue either one command at a time (step mode) or until a specified command or unit is reached (breakpoint mode). **debug off** returns to normal execution.

The debugging tool is exited by:

- executing **debug off**

- pressing [ESC] to quit debugging
- exiting through the System Tools window
- returning to the editor (normally via [SHIFT][F2])
- an execution error

5        **debug** is normally functional only during source mode execution. It can be made functional in binary mode by choosing that option when making the binary. **debug** does not function with the student executor.

The debugger can also be entered while running a unit by pressing [SHIFT][2], then selecting **Debug** from the **System key options** menu.

## 10    **device**

**Controls TenCORE device drivers.**

---

**device**    device, function [ , variable [ ,length ] ]

device        device number to call, in the range 0 to 255

function      device-specific function number to call, in the range 0 to 255

15        variable      data variable needed by the specified function

length        length of *variable*, if other than the defined length

---

### **Description**

**device** allows authors to control hardware devices not directly supported by the TenCORE language, but which are implemented through TenCORE device support files. These include special mouse, touch-panel, and interactive video features which go beyond the standard support built into TenCORE commands. The *variable* tag is used only if the function requires a data variable.

20

## Device Support Files

To use **device**, a TenCORE device support file is required. The device support file is executed (loaded) before starting the TenCORE executor, and remains resident in memory. Usage of **device** depends on the device support file being addressed.

## 5 System Variable

### zreturn

Set to the processor register AL before returning. Some device support files use this feature to return status information.

## disable

## 10 Disables system features (opposite of enable).

---

### disable keyword/s

|    |                 |                                                                                   |
|----|-----------------|-----------------------------------------------------------------------------------|
|    | <b>pointer</b>  | disables pointer display and all pointer input                                    |
|    | <b>ptrup</b>    | disables pointer-up inputs                                                        |
|    | <b>cursor</b>   | disables blinking cursor on text mode displays                                    |
| 15 | <b>arrow</b>    | disables plotting of the <b>arrow</b> prompt                                      |
|    | <b>absolute</b> | disables absolute screen plotting                                                 |
|    | <b>break</b>    | disables <b>break</b> modified <b>flow</b> branching from interrupting processing |
|    | <b>area</b>     | disables <b>area</b> input                                                        |
|    | <b>font</b>     | plots characters from charsets instead of fonts                                   |
| 20 | <b>mode</b>     | disables mode changes embedded in text                                            |

Multiple features can be disabled by a single disable statement. See the **Defaults** section for the initial state of these system features.

---

## Description

### **disable pointer**

Turns off display of the pointer and all input from the pointing device.

### **disable ptrup**

- 5           Turns off button-up input from the pointing device.

### **disable cursor**

Disables the blinking cursor for text mode screens.

### **disable arrow**

- 10           Disables plotting of the **arrow** prompt character ➤ and trailing space. User input occurs exactly at the location given in the **arrow** command.

### **disable absolute**

Turns off the **enable absolute** plotting mode and causes subsequent screen graphics to be modified by **scale**, **rotate**, **window**, and **origin** commands.

### **disable break**

- 15           Disables **break** modified **flow** branching from interrupting program execution. **flow** branching still occurs at the standard input processing locations (see the **flow** command for description). **break** is often disabled over a block of critical coding that must be completed in its entirety (e.g., file manipulations and their **zreturn** checks). Care must be taken to avoid disabling **break** while in a programming loop with no other means of exit. Since system routing keys such  
20 as [SHIFT][1] and [SHIFT][2] are turned off by **disable break**, a system hangup can occur.

### **disable area**

Turns off **area** input. New **areas** can be defined while **area** input is disabled, but input from them will not occur until **area** input is enabled.

**disable font**

Plots characters from charsets rather than fonts. Charsets are an obsolete form of character definition.

**disable mode**

- 5 Turns off mode changes embedded in text.

**Defaults**

The system defaults for the **enable** and **disable** command features are set by the **initial** command to the following:

|    |            |                                  |
|----|------------|----------------------------------|
|    | <b>ON</b>  | area, arrow, break, font, mode   |
| 10 | <b>OFF</b> | absolute, cursor, pointer, ptrup |

**Status of Disable Features**

The current ON/OFF status of the system features affected by the **disable** command are found in the bitmap of the 4-byte system variable **zenable**.

|    | <b>zenable BIT</b> | <b>FEATURE</b> |
|----|--------------------|----------------|
| 15 | 1                  | absolute       |
|    | 2                  | pointer        |
|    | 3                  | mode           |
|    | 4                  | cursor         |
|    | 5                  | ptrup          |
| 20 | 6                  | font           |
|    | 7                  | area           |
|    | 12                 | break          |
|    | 13                 | arrow          |

Use the **bit** function to examine **zenable**. A bit set implies ON while unset implies OFF.

For example:

bit(zenable,2) = -1 means **pointer** ON

bit(zenable,2) = 0 means **pointer** OFF

## 5 Example

All **flow** branching is turned off while attaching a file and checking for success.

```

flow do; %f10; glossary; break $$ a flow break branch
...
disable break $$ prevent interruptions
10 attach 'afile'; nameset $$ attempt to open file
jump zreturn;;erroru $$ check success
enable break $$ re-enable flow breaks

```

## do

Executes a unit as a subroutine.

---

```

15 do UNIT [([argument/16s] [; return/16s])]
do SELECTOR; UNIT [([argument/16s] [; return/16s])]; ...

```

---

## Description

Executes the specified unit as a subroutine. Upon completion of the subroutine, execution resumes with the command following the **do**. Subroutines can be nested up to 20 levels deep.

20 The unit which contains the **do** command is sometimes referred to as the *calling* unit; the subroutine is the *called* unit.

If a jump branch to a new main unit occurs while in a subroutine, execution does not return to the command following the **do** and the **do** stack is cleared.



**do** can pass up to 16 arguments to a subroutine and receive up to 16 arguments from a subroutine. A semicolon separates the send argument list from the receive argument list, while a comma separates arguments within a list.

The *called* unit must accept the passed arguments with a **receive** command (unless a **nocheck receive** command is in effect) or an execution error will occur. The *called* unit must return any required return arguments using the **return** command (unless a **nocheck return** is in effect) or an execution error will occur. See **receive**, **return**, and **no check**.

All arguments are passed and returned by value. However, the address of a variable can be sent as a value using the **varloc ( )** function.

## 10 Examples

### Example 1

When writing courseware, it is advantageous to put displays and routines that will be used in multiple places into one place that can be called as a subroutine when needed. Unit *header* can contain coding for a title bar that will appear on all pages for this segment of the lesson. Unit *diagram1* can plot an image and other graphics that will be common for this segment of the lesson. The **do** call to unit *navigate* in lesson *tools* is used to show the standard display of student navigation options available throughout all lessons in this series of lessons.

```

do header $$ in current lesson
do diagram1 $$ in current lesson
20 at 20:10
write This diagram shows the system we will be studying
 next at the start of its combustion cycle.
do tools,navigate $$ in lesson tools

```

**Example 2**

The **do** statement passes the value 3 to the subroutine *month* to request that it return the numerically identified month's name and number of days. The **do** command's argument list is divided into two parts separated by a semicolon: the first part is for sending arguments, the

5 second part is for receiving arguments.

```

define local
name,8
days,1
define end
10 do month(3; name,days) $$ get the name and days
*
* in the 3rd month
write «a,name» has «s,days» days.
*
unit month
15 define local
lnumber,1
lname,8
ldays,1
define end
20 receive lnumber $$ obtain month number argument
packzc lnumber; lname ; ; ; ;January;February;Harch;April...
calcs lnumber; ldays <= ; ; 31; 28; 31; 30...
return lname,ldays $$ return the name and days

```

**Example 3**

25 The expression *score < 75* is used as a true/false selector to choose either unit *sad* or *smile* which graphically shows a student's status with a sad or smiling face image.

```
do score < 75;sad; smile
```

**dot**

Plots a single pixel on the screen.

---

**dot**    [ LOCATION ]

---

**Description**

5            Plots a single pixel on the screen in the current plotting mode and color, at the specified location. If no location is specified, the current location (**zx,zy**) is used.

The **dot** command is affected by **thick**. With **thick on**, all dots are plotted two pixels thick; with **thick off**, dots are plotted one pixel thick.

**Examples**10        **Example 1**

Displays a dot at the location of the mouse pointer (**zinputx,zinputy**) when the pause is broken.

```
enable pointer
```

```
pause pass= %pointer
```

```
15 dot zinputx,zinputy
```

**Example 2**

Draws a sine wave using **dot**.

```
define local
```

```
 x ,8,r $$ a real variable for the x-coordinate
```

```
20 define end
```

```
 *
```

```
 loop x ← 0, 2* π, 0.1
```

```
 . dot 50*x, 100+50*sin(x)
```

```
 endloop
```

**System Variables**

|           |                                            |
|-----------|--------------------------------------------|
| <b>zx</b> | Current horizontal graphic screen location |
| <b>zy</b> | Current vertical graphic screen location   |

**draw**

5       **Draws lines between screen locations.**

---

**draw**    [ *LOCATION* ]; [ *LOCATION* ]; [ *LOCATION* ];...

---

**Description**

Plots lines on the screen in the current plotting mode and color. A line is drawn between each location separated by a semicolon. When a double semicolon (;;) is reached, **draw** skips to  
 10    the next location.

A single **draw** command can be continued on more than one line. If the tag starts with a semicolon, the line starts at the current screen location.

With **thick on**, all dots are plotted two pixels thick; with **thick off**, dots are plotted one pixel thick.

15       **Examples**

**Example 1**

Draws a box and a triangle on the screen with one **draw** command. Note the double semicolon to separate the two figures and that the drawing is continued over multiple lines.

**draw**        10,10; 80,10; 80,100; 10,100; 10,10;; 10,130;  
 20              100,130; 10,190; 10,130

**Example 2**

Draws connected line segments at random locations on the screen (or window). The starting semicolon is used to start each draw at the current screen location which is the ending point of the previous draw.

```

5 loop
 . color randi (1,15) $$ choose random color
 . draw ;randi (0,zdispx) , randi (0, zdispy)
 . delay .01
endloop

```

10 **ellipse**

**Draws an ellipse.**

---

**ellipse** *Xradius, Yradius* [, *fill* | *angle1, angle2* ]

---

**Description**

Draws an ellipse (or portion of an ellipse) with the center at the current screen location. If

15 the **fill** keyword is specified, the ellipse is filled with the current foreground color. The current screen location is not altered after a full ellipse is drawn: multiple ellipses can be drawn with the same center without resetting the screen location.

The two-tag form draws a full ellipse. The four-tag form draws only the arc of the ellipse specified by the starting and ending angles. Arcs are always drawn counter-clockwise from the

20 first angle to the second angle. For example, **ellipse 100,60,0,90** draws one quarter of an ellipse. The command **ellipse 100,60,90,0** draws three-quarters of an ellipse. The current screen location is updated after an arc is drawn (a four-tag **ellipse**).

**Example**

Draws an ellipse and two arcs centered on the screen.

```

at zxmax/2, zymax/2 $$ set the center of the ellipse
ellipse 95, 50 $$ draw a full ellipse
5 ellipse 90, 40, 0, 90 $$ draw a quarter of an ellipse
at zxmax/2, zymax/2 $$ reset the center of the ellipse
ellipse 70, 30, 90, 0 $$ three-quarters of an ellipse

```

**else**

Alternate case for if/else programming structure.

---

10 else

---

**Description**

Should the conditions of the previous **if** and **elseif** commands be false, the indented commands between **else** and **endif** are executed. An **else** command is not required in an if structure. For more information on if structures, see the **if** command description.

15 **Example**

```

if score > 90
. write Very Good!
elseif score > 75
. write OK, but you could do better.
20 else
. write You need more practice.
endif

```

**elseif**

Conditional case for if/else programming structure.

---

**elseif** *CONDITION*

---

**Description**

- 5        If the tags of the **if** command and all previous **elseif** commands evaluate false and the tag on the current **elseif** command evaluates true, the following indented commands are executed. Control then passes to the command following the **endif**. For more information on if structures, see the **if** command description.

**Example**

```

10 if score > 90
 . write Very Good!
elseif score > 75
 . write OK, but you could do better.
else
15 . write You need more practice.
endif

```

**enable**

Enables system features (opposite of disable).

---

**enable** keyword/s

20 **enable** «*vadable4*»

|                |                                                |
|----------------|------------------------------------------------|
| <b>pointer</b> | turns on pointer display and pointer input     |
| <b>ptrup</b>   | enables pointer-up inputs                      |
| <b>cursor</b>  | turns on blinking cursor on text mode displays |

|   |                 |                                                                                |
|---|-----------------|--------------------------------------------------------------------------------|
|   | <b>arrow</b>    | re-enables plotting of the arrow prompt                                        |
|   | <b>absolute</b> | turns on absolute screen plotting                                              |
|   | <b>break</b>    | re-enables <b>break</b> modified <b>flow</b> branching to interrupt processing |
|   | <b>area</b>     | re-enables <b>area</b> input                                                   |
| 5 | <b>font</b>     | re-enables <b>font</b> plotting                                                |
|   | <b>mode</b>     | re-enables mode changes embedded in text                                       |

Multiple features can be enabled by a single **enable** statement. See the **Defaults** section for the initial state of these system features.

---

### Descriptions

#### 10 **enable pointer**

Turns on display of the pointer and input from the pointing device.

#### **enable ptrup**

Enables button-up input. Unless **ptrup** is enabled, the pointing device generates input only when a button is depressed

#### 15 **enable cursor**

Turns on a blinking cursor for text mode screens. This command has no effect on graphic screens.

#### **enable arrow**

Re-enables plotting of the **arrow** prompt character ➤ and trailing space.

#### 20 **enable absolute**

Turns on absolute screen plotting mode. Subsequent screen graphics are not modified by **scale**, **rotate**, **window** and **origin** commands. The **scale**, **rotate** and **origin** commands are effectively turned off while **window** becomes modified by **relative** off and **clip** off.



**enable break**

Re-enables **break** modified **flow** branching to interrupt program execution.

**enable area**

Re-enables **area** input. Any previously defined current **areas** including those defined while  
 5 **area** input was disabled are now active.

**enable font**

Returns to using fonts instead of charsets for character plotting. Charsets are an obsolete form of character definition.

**enable mode**

10 Re-enables mode changes embedded in text.

**enable «variable4»**

The variable form of the **enable** command is used to enable/disable all features according to their bit settings in a 4-byte variable. The variable is usually a saved copy of the system variable **zenable** that is used to later reset all features back to a previous state. The feature  
 15 bitmap is discussed in the following section **Status of Enable Features**.

**Defaults**

The system defaults for the **enable** and **disable** command features are set by the **initial** command to the following:

|        |                                         |
|--------|-----------------------------------------|
| ON     | <b>area, arrow, break, font, mode</b>   |
| 20 OFF | <b>absolute, cursor, pointer, ptrup</b> |

**Status of Enable Features**

The current ON/OFF status of the system features affected by the **enable** command are found in the bitmap of the 4-byte system variable **zenable**.

|                    |                |
|--------------------|----------------|
| <b>zenable BIT</b> | <b>FEATURE</b> |
|--------------------|----------------|

|   |    |          |
|---|----|----------|
|   | 1  | absolute |
|   | 2  | pointer  |
|   | 3  | mode     |
|   | 4  | cursor   |
| 5 | 5  | ptrup    |
|   | 6  | font     |
|   | 7  | area     |
|   | 12 | break    |
|   | 13 | arrow    |

10 Use the **bit** function to examine **zenable**. A bit set implies ON while unset implies OFF.

For example:

`bit(zenable,2) = -1` means **pointer** ON

`bit(zenable,2) = 0` means **pointer** OFF

#### Example

15 The absolute screen coordinates of the pointer are displayed at the pointer location. The coordinates and display are relative to the physical screen and not affected by any **window**, **origin**, **rotate** or **scale** commands.

```

enable pointer,absolute $$ turn on pointer and absolute
20 loop
. pause $$ move mouse then press button
. at zinputx,zinputy $$ at pointer location
. write <s,zinputx> - <s,zinputy> $$ show coordinates
endloop

```

**endif**

Ends if/else programming structure.

---

**endif**

---

**Description**

- 5 Marks the end of an if structure. Every **if** must have a matching **endif** at the same indent level. For more information on if structures, see the **if** command description.

**Example**

```
if score > 90
. write Very Good!
10 elseif score > 75
. write OK, but you could do better.
else
. write You need more practice.
endif
```

**endloop**

Ends loop programming structure.

---

**endloop**

---

**Description**

- 20 Marks the end of a loop structure. Every **loop** must have a matching **endloop** at the same indent level. For more information on **loop** structures, see the loop command description.

**Example**

Fifty X's are written on the screen.

```

loop index ⇐ 1,50
. write X
endloop

```

## erase

- 5           **Erases a box, frame or characters on the screen.**

---

```
erase [LOCATION] [; [LOCATION] [; Xframe [, Yframe]]]
```

---

### Description

Erases a box or frame on the screen to the background color. See the Command Syntax Conventions for a description of *LOCATION*. The **box** command is identical to **erase** except that  
 10 it uses the foreground color for drawing.

The presence of a frame width argument signifies that a frame rather than solid box be erased. The widths of the right and left sides are specified in pixels by the first frame argument while the second frame argument specifies the top and bottom widths. If the second frame argument is absent, the top and bottom frame width is set to best match the side width in aspect  
 15 appearance on the screen.

### Examples

#### Example 1

The entire screen (or window) is erased to blue.

```

colore blue
20 erase

```

#### Example 2

A rectangle 200 pixels wide by 100 pixels high is erased to the background color. Graphic coordinates are used to specify each x,y coordinate for a location.

```
erase 101,101; 300,200
```

### Example 3

The text in a **write** statement is later erased after a pause. The **text measure** command is used to determine the screen area that a following paragraph of text plots over on the screen.

- 5 This information is returned in the system variables **zplotxl**, **zplotyl** for lower left corner and **zplotxh**, **zplotyh** for upper right corner.

```
text measure $$ initialize text measuring
*
at 100,150
10 write This is a paragraph of text of arbitrary
 length that will be erased...
*
pause
erase zplotxl, zplotyl; zplotxh, zplotyh
```

### 15 Example 4

Ten characters are erased.

```
at 10:1
erase 10
```

### error

- 20 Specifies an execution error unit.

---

```
error [UNIT]
```

```
error SELECTOR ; UNIT ; UNIT ; ...
```

---

**Description**

Sets the execution error lesson and unit. Whenever an execution error occurs, the system jumps to the unit specified with **error**. If no unit has been specified, a TenCORE system error message is displayed.

- 5           The blank-tag form clears the error lesson and unit. The setting of the error unit remains in effect until another **error** command is encountered.

The "error unit" is normally set by the router lesson when the system is started.

- When **error** is executed, the current mode of operation, (binary or source), is saved along with the error lesson and unit names. If an error causes a branch to the error unit, the saved mode of operation is used to decide whether to fetch the error unit from a binary file or a source file.
- 10

**System Variables**

|                |                          |
|----------------|--------------------------|
| <b>zerrorl</b> | Name of the error lesson |
| <b>zerroru</b> | Name of the error unit   |

**exchang**

- 15           Exchanges the contents of two areas of memory.

---

**exchang** *keyword*, offset; *keyword*, offset; length

|    |                                           |                           |
|----|-------------------------------------------|---------------------------|
|    | <i>keyword</i> <b>routvars</b>   <b>r</b> | Router variables          |
|    | <b>display</b>   <b>d</b>                 | CGA screen display memory |
|    | <b>global</b>   <b>g</b>                  | Global variables          |
| 20 | <b>local</b>   <b>l</b>                   | Local variables           |
|    | <b>sysvars</b>   <b>s</b>                 | System data area          |
|    | <b>sysprog</b>   <b>p</b>                 | System program area       |
|    | <b>absolute</b>   <b>a</b>                | Absolute memory location  |

|        |                             |
|--------|-----------------------------|
| offset | offset from memory base     |
| length | number of bytes to exchange |

### Description

Exchanges bytes between two areas of memory. Up to 65,535 (64K-1) bytes can be  
 5 exchanged. An offset of 0 specifies the beginning of the area of memory.

For relative addressing, TenCORE divides the computer memory into areas, each with its own keyword. A location is specified by providing a keyword, then an offset. An offset of 0 specifies the first byte of that area.

Additional information about each keyword:

- |    |                 |                                                                                                                                                                                                                                                                                |
|----|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10 | <b>routvars</b> | This is a 256-byte area of memory which can be accessed only via <b>exchang</b> and <b>transfr</b> . This area is used by the Student Router for storing data while a user is in an activity. If using this router, be careful not to modify the first 128 bytes of this area. |
| 15 | <b>display</b>  | CGA screen display memory. The display memory for other display types (EGA, VGA, etc.) cannot be accessed with <b>exchang</b> .                                                                                                                                                |
|    | <b>sysvars</b>  | Do not use this area for data storage.                                                                                                                                                                                                                                         |
|    | <b>sysprog</b>  | Do not use this area for data storage.                                                                                                                                                                                                                                         |
|    | <b>absolute</b> | Programs which reference absolute memory locations may not work in multi-tasking environments.                                                                                                                                                                                 |

20 Because **exchang** can access any area of memory in the computer, it should be used with caution.

When specifying an offset in variables, the **varloc( )** function can be used to specify the offset of a particular variable.

Similarly, an absolute memory location can be specified using the **absloc( )** function.

Note, however, that **absloc()** may not work properly on multi-tasking operating systems such as Windows or OS/2.

Locally defined names have precedence over globally defined names when using **varloc( )**.

- 5 This could cause unexpected results when **varloc( )** is used with **exchang**.

### Examples

#### Example 1

The expression *varloc(scorvar)* specifies the beginning of global variables containing user scores.

```
10 exchang global, varloc(scorvar); routvars,128; 128
```

```
* Uses 2nd half of routvars
```

#### Example 2

Makes certain that the 2-byte value in *X0* is less than or equal to the 2-byte value in *X1*.

```
15 if x0 > x1
 . exchang global,varloc (X0) ;global,varloc (X1) ;2
endif
```

### **exec**

**Executes a DOS program or command.**

---

```
20 exec keyword...
```

**command** executes a program or command through the DOS command processor, or provides access to the DOS prompt

**file** executes a program directly

---



## Descriptions

### **exec command [, all | memorySize ]**

Provides access to the DOS command line prompt. To return to TenCORE, type **exit** at the DOS prompt.

- 5       DOS memory not currently used by TenCORE is available for use by programs or commands entered at the DOS prompt. If the **all** option is specified, as much DOS memory as possible is made available by temporarily removing most of TenCORE. If a memory size is specified, the system attempts to free the specified number of kilobytes of memory. Note that the DOS command processor uses a part of this memory.

### 10   **exec command [, all | memorySize ]; buffer [,length ]**

The DOS command processor is loaded and passed the buffer to execute as if its contents had been typed at the DOS prompt. Features of the DOS prompt such as path search and batch file execution are available. If the length is not specified, the defined length of the buffer is used; unused bytes at the end of the buffer should be zero-filled.

- 15       DOS memory not currently used by TenCORE is available for use by the passed program or command. If the **all** option is specified, as much DOS memory as possible is made available by temporarily removing most of TenCORE. If a memory size is specified, the system attempts to free the specified number of kilobytes of memory. The DOS command processor uses a part of this memory.

### 20   **exec file [ ,all | memorySize ]; buffer [,length ]**

Executes *.EXE* and *.COM* files (only). The complete file name (including the *.EXE* or *.COM* extension), as well as drive and path must be specified. The features of the DOS command processor such as path search and batch file execution are not available. Any characters starting with the first space or slash (/) are passed as arguments to the executed file. if the length is not

specified, the defined length of the buffer is used; unused bytes at the end of the buffer should be zero-filled.

DOS memory not currently used by TenCORE is available for use by the executed file. If the **all** option is specified, as much DOS memory as possible is made available by temporarily removing most of TenCORE. If a memory size is specified, the system attempts to free the specified number of kilobytes of memory.

The **file** form of **exec** is more efficient than the **command** form as the DOS command processor is not loaded. This form also allows access to error reports for the executed program (the **command** form provides error reports for the DOS command processor).

## 10 Examples

The following defines are used for all the following examples.

```
define local
buf, 100
define end
```

## 15 Example 1

Uses the **command** form of **exec** to allow any DOS directive or program name typed at an arrow to be executed. As much memory as possible is made available.

```
write Enter DOS command to execute:
long 100
20 arrow
storea buf $$ store input into variable
ok
endarrow
exec command,all,buf
25 writec zreturn;;Error: zreturn = «showt,zreturn»
```

**Example 2**

Uses the **command** form of **exec** to copy all TenCORE datasets in the current directory to drive a:. As much memory as possible is made available.

```
packz buf;;xcopy *.dat a:
5 exec command,all;buf
writec zreturn;;Error: zreturn = «showt,zreturn»
```

**Example 3**

Uses the **file** form of **exec** to call the Autodesk Animator animation program *QUICKFLI.EXE* in directory *D:\PROGS* to play the animation *BACKHOE.FLI* in directory *C:\ANIMS*. 250 kilobytes of memory are requested.

```
screen mcga,medium
packz buf;;d:\progs\quickfli.exe c:\anim\backhoe.fli
exec file,250;buf
writec zreturn;;Error: zreturn = «showt,zreturn»
```

15      **System Variables**

The **exec** command sets the following system variables.

**command** form:

|    |                |                                                                                                     |
|----|----------------|-----------------------------------------------------------------------------------------------------|
|    | <b>zreturn</b> | reports on success of operation                                                                     |
|    | -1             | DOS command processor successfully executed.                                                        |
| 20 | 0              | insufficient memory to load DOS command processor, or unable to provide requested amount of memory. |
|    | 1              | DOS command processor (COMMAND.COM) not found.                                                      |

**file** form:

|    |                |                                 |
|----|----------------|---------------------------------|
|    | <b>zreturn</b> | reports on success of operation |
| 25 | -1             | program successfully executed   |

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0       insufficient memory to load program, or unable to provide requested amount of memory.

1       program no found.

**zerrlevl** DOS ERRORLEVEL value as returned by executed **program**.

5       Both forms also set the system variables **zedoserr** and **zerrcode** which provide extended DOS error information.

## exitsys

Exits to DOS or to the program which called TenCORE.

---

**exitsys** [ *error* [ ,**noerase** ] ]

10       *error*       1-byte integer value passed to the DOS variable ERRORLEVEL

**noerase**   the screen mode is not changed and the screen is not erased

---

### Description

Returns control back to the program which called the TenCORE executor. Normally, the user is returned to the DOS prompt. If TenCORE was started via a DOS batch file, the next

15   command in that batch file is executed. If *error* is specified, the value is passed to the DOS variable ERRORLEVEL, where it can be tested using DOS commands. If the **noerase** keyword is present, the screen mode is not changed and the screen is not erased. This keyword can only be specified when using the return value *error*.

### ERRORLEVEL Values

20       TenCORE uses ERRORLEVEL values to indicate various error conditions. Authors are advised against using values 0 to 31 with **exitsys**.

0       Normal exit via exitsys (no tag)

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|    |       |                                                         |
|----|-------|---------------------------------------------------------|
|    | 1     | Copy protection violation                               |
|    | 2     | Error in TenCORE command line options                   |
|    | 3     | Insufficient memory to execute TenCORE                  |
|    | 4     | Display driver not found                                |
| 5  | 5     | Error in display driver (e.g., invalid revision number) |
|    | 6     | Error in syntax of TenCORE environment string           |
|    | 7-15  | Reserved for later use                                  |
|    | 16    | Initial unit not found                                  |
|    | 17    | No startup found in first unit executed                 |
| 10 | 18    | Initial unit version incompatible with executor         |
|    | 19    | All drives excluded by TCDISKS or TCSEARCH              |
|    | 20-30 | Reserved for later use                                  |
|    | 31    | [SHIFT][7] pressed from generic Execution Error display |

**extin**

15      **Reads data from an external I/O port.**

---

|              |                                      |
|--------------|--------------------------------------|
| <b>extin</b> | port, buffer, length                 |
| port         | address of the I/O port to read from |
| buffer       | buffer to receive data from the port |
| length       | number of bytes to receive           |

---

20      **Description**

Reads the specified number of bytes from the specified external I/O port. This command can be used to control external devices via a serial or parallel port. Consult the *IBM Technical*

*Reference Manual* for details on addressing and controlling the serial and parallel ports. **extout** is the counterpart to **extin**.

### Examples

#### Example 1

5 Reads one byte of data from COM1.

```
define local

rstatus , 1 $$ the variable to read into

define end

*

10 extin 1016,rstatus,1

* read 1 byte from address 1016 (h3F8) into rstatus
```

#### Example 2

Uses **extin** and **extout** to send a byte to the **COM1** port using xon/xoff protocol. This routine could form the basis of a routine to control a printer.

```
15 define local

status ,1 $$ status flags for com1:

dr ,1 $$ data ready, bit 0 of the status bits

* if this bit is set, there is data ready to read

rstatus ,1 $$ a character read from com1:

20 tx ,1 $$ transmitter status. If 0, the port is

* ready to accept another character to transmit

xonoff ,1 $$ xon/xoff flag. If 1, xoff, else xon.

char ,1 $$ a character to send out the port

*

25 lsr = 1021 $$ line status register address

rxvar = 1016 $$ receive variable register address

txvar = 1016 $$ transmitter variable register address
```

```

define end
*
loop
. loop
5 . . extin lsr,status,1
* . now check the first bit of the status,
* . see if xon/xoff was sent
. . calc dr ← status $mask$ 1
. outloop dr = 0 $$ no xon/xoff, so proceed
10 * if there was xon/xoff, read it and set the flag
. . extin rxvar,rstatus,1
. . calcs rstatus=17; xonoff ← 0,1
. endloop
reloop xonoff = 1 $$ xoff, so loop again
15 * now check bit 5 of the status to see if it's ok to send
* another character
. calc tx ← status $mask$ 32
outloop tx=32 $$ if ok, send it, otherwise loop again
endloop
20 extout txvar,char,1 $$ send the character

```

## extout

Writes data to an external I/O port

---

extout port, buffer, length

|    |        |                                                |
|----|--------|------------------------------------------------|
|    | port   | address of the I/O port to write to            |
| 25 | buffer | buffer containing the data to send to the port |
|    | length | number of bytes to send                        |

---

**Description**

Writes the specified number of bytes to the specified external I/O port. This command can be used to control external devices via a serial or parallel port. Consult the *IBM Technical Reference Manual* for details on addressing and controlling the serial and parallel ports. **extin** is the counterpart to **extout**.

**Examples****Example 1**

Writes the contents of *rstatus* to COM1.

```
define local
10 rstatus ,1
define end
*
extout 1016,rstatus,1 $$ writes rstatus to COM1 (h3F8)
```

**Example 2**

See the **extin** command description, Example 2 for an additional example.

**fill**

Fills any bounded area on the screen.

---

**fill**     [ color [, boundary ] ]

color       color to fill with

20       boundary   color which defines the boundary of the area to be filled

---



### Description

Fills an enclosed area with a specified color starting at the current cursor position. If no *color* is specified, the area is filled with the current foreground color. If no *boundary* color is specified, the fill stops at any color different from the original color of the beginning point.

5 If the area to be filled is not closed the entire screen is filled.

The **fill** command usually follows an **at**, which sets the point at which the fill is to begin.

Fill does not use the current plotting mode: the specified color always appears regardless of mode.

### Example

10 Produces a red circle inscribed with a bright white triangle outline. After the first delay, the top segment of the triangle is filled with cyan. After the second delay, the top segment becomes magenta. After the last delay, the entire triangle becomes solid blue with a white outline.

```

screen vga
color red
15 at 320,216
 circle 65, fill
 color white+
 draw 320,335; 200,150; 440,150; 320,335
 delay 1
20 color cyan
 at 320,334
 fill
 delay 1
 fill magenta
25 delay 1
 fill blue, white+
```

**find**

Finds the position of a data object within a list.

---

|             |                                                   |
|-------------|---------------------------------------------------|
| <b>find</b> | object, length, buffer, entries, incr, return     |
|             | object      data to search for                    |
| 5           | length      length of the object in bytes         |
|             | buffer      variable to begin search              |
|             | entries      number of entries in list            |
|             | incr      length of each entry in buffer in bytes |
|             | return      entry number of first match           |

---

10      **Description**

Searches a list of character or numeric entries for the desired object string. **find** will search for the object every *incr* bytes, from the beginning of *buffer* without attention to defined sizes or boundaries of variables. It considers *buffer* to be the first byte of a list whose characteristics are defined entirely by *entries* and *incr*.

15      If *incr* is negative, the search proceeds backwards from the end of the list to the start.

*return* indicates the position in the list where *object* was found, with the first entry being 1. If the object is not found, -1 is returned. The value in *return* is always relative to the beginning of the list, even if the search is backwards.

**Examples**

20      The examples below all assume the following defines.

```
define local
name,15 $$ name to search for
found,2 $$ position in list where "name" found
```

```
list(5),15 $$ list of names
define end
```

In each example, *list* contains 5 names, each of which occupies 15 characters. The contents are as follows:

```
5 John miller....mark ho.....sarah johnston.james heflin...lisa berger....
 ↑ ↑ ↑ ↑ ↑
 1 16 31 46 61
```

Null characters have been shown as dots to improve their visibility, and numbers have been added to help in counting bytes.

#### 10 Example 1... Literal Object

Searches for the name 'mark ho'.

```
find 'mark ho',7,list(1),5,15,found $$ found will be 2
```

Because the name has 8 or less characters, it can be supplied as the text literal 'mark ho'.

Next comes the length, 7 characters. The start of the list is given as *list(1)*, and its length as 5

15 entries of 15 bytes each.

After the *search,found* contains the value 2 because 'mark ho' is found at the second position (not the second byte) in the list.

#### Example 2...Variable Object

Objects of more than 8 bytes cannot be given as text literals and must occur in variables.

20 To locate 'james heflin':

```
packz name;;james heflin
find name,15,list(1),5,15,found
```

The variable *found* receives the value 4 because 'james heflin' is found in the fourth position.

### Example 3...Byte-by-Byte

To find a last name.

```
packz name;;miller
find name,6,list(1),75,1,found
```

5 When this example is executed, *found* receives the value 6.

Note that the length of the name is given as 6 because this locates part of an entry, not an entire entry.

Similarly, the list is specified as 75 one-byte entries instead of 5 fifteen-byte entries. This causes **find** to look for 'miller' starting at every byte, not just at the start of each 15-byte entry.

10 This illustrates that the object of the search can be longer than the nominal entry length provided for it.

### Example 4...Backwards Search

To search backwards, a negative value is given for the entry length. This searches backwards from the end of the list for 'john', looking only at the beginning of each 15-byte entry.

```
15 find 'john',4,list(1),5,-15,found
```

Here, *found* receives the value 1. Although the search proceeded backwards from the end of the list, the position is always counted from the beginning of the list.

### Example 5...Backwards Byte-by-Byte

Another example of backwards searching is the following.

```
20 find 'john',4,list(1),75,-1,found
```

In this case, an entry length of -1 is used, causing **find** to look at every character starting from the end of the list.

*found* receives the value 37, because the first 'john' found when searching backwards byte-by-byte occurs in 'sarah johnston'. If the search had been in the forward direction, 'john miller'

25 would have been found first, and *found* would have received the value 1.

**flow**

**Manages lesson flow by event-driven unit branching.**

---

**flow** keyword...

**jump** defines event driven unit branch with screen erase

5 **jumpop** like **jump** but without screen erase

**do** defines event driven subroutine call

**library** like **do** but forces a binary subroutine call

**clear** clears active flow event settings

**save** saves active set of flow events

10 **restore** restores saved set of flow events to active status

**delete** deletes saved set of flow events

**reset** deletes all saved sets of flow events

**dir** returns list of active flow events

**info** provides flow branch data about active flow event

---

15 **Description**

Manages event-driven branching. Events can be keypresses, pointer inputs, time-ups, etc.

A specific event can trigger a jump to a new main unit or a subroutine call.

Up to 50 different events can be active at a given time. A set of flow events and associated branches can be defined as the default environment for all new main units throughout a lesson. Advanced options can manipulate a lesson's flow settings so as to provide a clean connection to a router or library routines.

Flow events normally occur at waiting states within a lesson:

- at a **pause** that allows flow key input
- at an **arrow** that processes user keypresses
- at the completion of a unit's execution ("end-of-unit")

A sequence of coding will not be interrupted by a flow event at any other place unless the  
 5 flow definition has been modified with **break** to allow for program interruption.

**flow jump | jumpop | do | library; KEY/s; UNIT [modifier; modifier;...]**

Defines a connection between a keypress (or other input event) and a branch to a unit.

The first argument is a keyword specifying the type of branch. *KEY* is described fully in the  
 Syntax Conventions section. Multiple keys separated by commas are allowed and when pressed  
 10 cause a branch to *UNIT*. A total of 50 different events can be active as created by multiple **flow**  
 commands. A given event is associated with one branch at a time. If the same event is defined in  
 two different flow commands, the most recent definition takes precedence. Modifiers alter the  
 standard operation of the command. Argument passing is not supported.

### **jump**

15 Ends the current unit and branches to a new main unit. The following initializations are  
 performed:

- the screen is erased to the default background color
- all **flow** events and **area** definitions are cleared and reset to their main unit defaults
- all display parameters are reset to their main unit defaults (as set by **status save; default**)
- 20 • the unit becomes the new main unit for processing and flow events

### **jumpop**

Ends the current unit and branches without a screen erase ("op" stands for "on page") to a  
 new main unit. Only the following initializations are performed:

- all **flow** events are cleared and reset to their new main unit defaults
- the unit becomes the new main unit for processing and **flow** events

**do**

Calls a unit as a subroutine. No initializations are performed. Return from the subroutine

5 unit continues execution at the place the **flow do** event occurred. 20 levels of nested subroutine calls are allowed. **flow do** executes in source or binary mode depending on the mode of the calling lesson.

### **library**

Calls a unit as a binary subroutine. No initializations are performed. Return from the

10 subroutine unit continues execution at the place the **flow do** event occurred. 20 levels of nested subroutine calls are allowed. **flow library** is frequently used for calling third party software where the coding exists only in binary form.

### **Example 1**

When [ENTER] is pressed, branches and passes control to *quiz1* in the current lesson.

15 The screen is erased and all display settings, flow branches, and pointer areas are reset to their main unit defaults. When [F8] is pressed, *moreinfo* is called as a subroutine and control remains with the calling unit. Unit *moreinfo* would contain coding to add new information to that already on the screen.

**write**      **Press Enter to Begin the Quiz.**

20              **Press F8 for more information.**

**flow**        **jump; %enter; quiz1**

**flow**        **do; %f8; moreinfo**

**Example 2**

Branches and passes control to unit *index* in lesson *aerol* when either [F1] or [ESC] is pressed. When [PG↑] is pressed, the binary subroutine *scroll* is executed. Control remains in the calling unit upon return from *scroll*

```

5 flow jump; %f1,%esc; aerol,index
 flow library; %pgup; scroll

```

**Example 3**

Branches to the unit named by the variable *unitVar* when any of the keys a, b, c or the value contained in the variable *xkey* is input.

```

10 flow jump; a,b,c, «xkey» ; «unitvar»

```

**Example 4**

Branches with a screen erase to *help* when either [F1] is pressed or a **Click** occurs on the associated area. Pressing [F2] or a **Click** on its associated area branches to *more* without a screen erase. In either case, control passes to the new unit.

```

15 area define; 100,0; 150,20; click=%f1
 area define; 200,0; 250,20; click=%f2
 flow jump; %f1; help
 flow jumpop; %f2; more

```

**Generic Unit Names**

20 Generic branch names are provided for common **jump** destinations to new main units:

**=next**            The next physical unit to the current main unit in the lesson. If none, the branch is ignored.

**=back**            The previous physical unit to the current main unit in the lesson. If none, the branch is ignored.

25 **=first**            The first executable unit in the current lesson.



|    |                |                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | <b>=last</b>   | The last executable unit in the current lesson.                                                                                                                                                                                                                                                                                                                                                                              |
|    | <b>=main</b>   | The current main lesson and unit as held in the system variables <b>zmainl,zmainu</b> .                                                                                                                                                                                                                                                                                                                                      |
| 5  | <b>=base</b>   | The main lesson and unit from which the last <b>base</b> modified <b>flow</b> branch occurred or as set by the <b>base</b> command. If none, the branch is ignored. The names of the current base lesson and unit are held in the system variables <b>zbasel,zbaseu</b> . Typically used for returning from a supplementary lesson sequence such as help to the main line of study. See <b>base</b> modifier on page \$\$\$. |
| 10 | <b>=editor</b> | The Source Editor (with the current executing unit as the source block being edited) if executed by the authoring system; ignored by the student executor.                                                                                                                                                                                                                                                                   |
| 15 | <b>=exit</b>   | The lesson exit as set by the <b>exitles</b> command and contained in the system variables <b>zexitl,zexitu</b> . Student users are typically branched back to their routing system such as the TenCORE Activity Manager or DOS if none is present. An author testing a lesson is returned to the File Directory.                                                                                                            |
| 20 | <b>=system</b> | Opens the system options window with the calculator, image capture, cursor, etc. [F2] is normally loaded with this branch as a TenCORE system default during authoring; ignored by the student executor.                                                                                                                                                                                                                     |

### Example 1

Branches to the unit following or preceding the current main unit in the lesson when [ESC] or [F6] is pressed. In the first or last unit of the lesson, the branch is ignored. This is an easy way to program the essential flow for a linear page-turning lesson.

```

flow jump; %enter; =next
flow jump; %f6; =back

```

### Example 2

When [ESC] is pressed, branches to the exit unit that was specified by the **exitles**

5 command in a router or, if none, then DOS.

```

flow jump; %escape; =exit

```

### Unanticipated Input

A flow event can be defined for all unanticipated input at one of the natural waiting states by using the pseudo-key **%other**. This "other" event occurs only if the input cannot be applied to

10 any other possible **flow** branch or input situation.

### Example 1

Causes any key inputs that would otherwise be discarded by the system to branch to unit *record* which, say, records these unanticipated inputs for later study.

```

flow do; %other; record; default; break

```

### 15 Example 2

At the **pause**, keys a, b and c continue execution of the unit. Any input specified in an active **flow** event such as [ENTER] and [F6] work as defined. Any other inputs branch to unit *continue*.

```

flow jump; %enter; =next
20 flow jump; %f6; =back
...
flow jump; %other; continue
...
pause flow=all;pass=a,b,c

```

**Example 3**

At the **arrow**, standard ASCII input such as a, b and c cause typing to appear on the screen as expected. Other **arrow** related functions such as erase, copy, judge-with-the-Enter key, etc. also perform as expected. Any defined **flow** event such as the branch to unit *aha* is active;

5 unanticipated keys such as an undefined [F12] branch to unit *help*

```
flow do; %other; help
```

```
flow jump; %f3; aha
```

```
...
```

```
arrow 10:20
```

10      **Modifiers**

Modifiers on a **flow** statement alter the default action of the command. Multiple modifiers separated by semicolons can be used and in any order although some are mutually exclusive.

15      **default**      Establishes the **flow** branch as a default setting for all subsequent new main units. **default** modified flow settings are cleared by an **initial** statement or by a **flow clear** statement with a **default** or **router** modifier. **default** settings for an entire lesson are often placed in the **+initial** control block of a lesson so that they are set with any entry to the lesson.

20      **complete**      Delays putting the **flow** command into effect until all processing in the unit is completed including any **pause** or **arrow** statements. The **flow** works only at the end-of-unit. For example, users can be required to complete all **arrows** in a unit before branching to the next unit. The **complete** and **break** modifiers cannot be combined.

25      **router**      Establishes the flow setting permanently over all following units. It is NOT cleared by an **initial** statement The **router** modifier allows management

software (such as the TenCORE Activity Manager) to permanently set keys for routing use in an application. **router** flow settings can be cleared only by using **flow clear** with the **router** modifier

For example, a **router** modified exit branch using [SHIFT][1] is set by the TenCORE system at start-up of the student executor to return users to DOS. If the Activity Manager is used, it resets this **flow** branch to exit users back to a return unit in the Activity Manager before launching an application.

Great care should be taken in clearing **router** flow settings in an application lesson as the user can become stuck in the application. The **router** and **break** modifiers are best used together unless you are certain that your lessons accept the router exit key in all situations.

**break** Allows the **flow** branch to occur at any point, interrupting any programming or **pause** in process. A **break** modified **flow** branch will always work unless temporarily turned off by **disable break**. The main use for **break** is to interrupt a programming loop that does not check for keys. The **break** modifier is often used with the **router** modifier by a router to guarantee that the exit branch will always work in application lessons. **break** cannot be combined with **complete**.

When a **break** modified **flow do** or **flow library** event interrupts commands being processed (as in a programming loop), the current program statement is completed, the subroutine is executed, then processing continues with the next statement. When a break occurs at a timed **pause** or **delay** command, the timing is suspended until return from

the subroutine. During the subroutine call, the **flow** event is temporarily disabled to avoid recursion and re-enabled upon exit from the subroutine. In addition, the following system variables are saved and restored over the subroutine call: **zinput**, **zinputf**, **zinputx**, **zinputy**, **zinputa**, **zreturn**.

5 Great care must be taken to avoid unreliable results when using **break** with the **do** or **library** form of **flow**. Since a **break** interrupt can occur anywhere, variables (especially system variables) can be accidentally changed in the interrupt **do** or **library** call level making them invalid upon return from the call. The **break** attribute should be turned off over critical coding by use of a **disable break** statement. See the following Example 4.

**clearkeys** Upon branching, deletes all pending input from the input buffer. **clearkeys** eliminates keys that may have been "stacked-up" waiting for some event to end, such as a lengthy full-page display.

**base** The **base** modifier on a **flow** branch causes the main lesson and unit from which the branch occurs to become the base lesson and unit and stored in the system variables **zbase1** and **zbaseu**. When a **base** modified **flow** branch initiates a supplementary lesson sequence, such as help, the **=base** generic *UNIT* location can be used to return the user to the starting base location.

20 **windowclose** Closes the current window, if any, before executing the **flow** branch.

**windowreset** Closes all open windows, if any, before executing the **flow** branch.

**operate** Before branching, restores the execution mode in effect when the flow statement was encountered. (See the operate command.)

|               |                                                             |
|---------------|-------------------------------------------------------------|
| <b>binary</b> | Before branching, changes to binary execution mode          |
| <b>source</b> | Before branching, changes to source execution mode.         |
| <b>tpr</b>    | Before branching, changes to tpr (Producer) execution mode. |

**Example 1**

- 5 Causes an immediate branch to the next linear unit in the lesson when the [ENTER] key is pressed. All subsequent main units will default to this flow setting. If this statement is to apply to the entire lesson, it should be placed in the **+initial** control block

```
flow jump; %enter; =next; default; break
```

**Example 2**

- 10 Sets [ESC] to be a router exit key. It is kept permanently over **initial** commands and will **break** any programming situation (unless **break** is disabled), close all windows, and jump to *route, return*.

```
flow jump; %escape; route,return; router; break; windowreset
```

**Example 3**

- 15 Branches to unit *ques6* if [ENTER] is pressed at an end-of-unit. Any **pause** or **arrow** must be completed first. Any other inputs "stacked-up" are removed.

```
flow jump; %enter; ques6; complete; clearkeys
```

**Example 4**

- 20 A library unit (*clock* in lesson *routines*) is installed to show the user the time whenever [F10] is pressed or when a %timeup input occurs. Within the library routine itself, a **time 1** statement is executed before exiting so that the %timeup key will keep occurring and "refresh" the clock every second while the user remains in the main unit. Critical coding in the lesson that may be affected by unexpected interrupts should be protected by disabling the **break** attribute over the coding, then enabling it again after the coding.

```

flow library; %f10,%timeup; routines,clock; break; default
...
disable break $$ protect critical coding
attach 'file';nameset $$ perhaps unit clock also does attach
5 do zreturn;;erroru
setname 'block' $$ and setname
...
enable break $$ re-enable break
flow clear [; [KEYS/s] [; default | router]]

```

- 10 Deletes flow settings from the active list and optionally from the new main unit **default** and the **router** lists. The **default** modifier is used to remove any **flow** definitions that have been set with the **default** modifier. The **router** modifier is used to remove both **router** and **default** modified flow settings.

#### Example 1

- 15 Deletes all active flow settings except those modified with **router**. Any settings made with the **default** modifier will be re-activated upon a **jump** to a new main unit.

```
flow clear
```

#### Example 2

- 20 Deletes any active flow settings for [ENTER] and [F6] unless they were defined with the **router** modifier. If either of these keys were defined with a **default** modifier, it will be re-activated upon a **jump** to a new main unit.

```
flow clear; %enter,%f6
```

#### Example 3

- 25 Deletes [ENTER] from the active and **default** flow settings unless it has the **router** attribute

```
flow clear; %enter; default
```

#### Example 4

Deletes all flow settings, except those modified with **router**, from both the active and default settings. An **initial** statement also performs this task.

```
5 flow clear;;default
```

#### Example 5

Completely deletes [ENTER] as a flow setting regardless of how it was set.

```
flow clear; %enter; router
```

#### Example 6

10 Deletes all flow settings regardless of how they were defined. Use with extreme caution for all the system **flow** settings such as [SHIFT][F1] are also removed preventing any exit unless otherwise provided for.

```
flow clear;;router
```

```
flow save;'NAME' | local
```

```
15 flow save; default
```

Saves the set of active flow definitions in a memory pool block or the **default** buffer. The name can be either a text literal or contained in a variable. Named blocks can be restored later in any unit.

The **local** keyword saves the flow settings in a memory pool block specific to the current unit. A local block can be restored only in the unit which saved it; it is deleted automatically when execution of the unit ends.

Saving the active **flow** settings to the **default** buffer makes them the default **flow** settings for all new main units. They are automatically reset on a **jump** or **jumpop** to another unit.

The memory pool is used by the commands: **memory**, **image**, **window**, **status**, **area**,  
25 **flow**, **font** and **perm**. Memory blocks are tagged as belonging to a specific command type at



creation and cannot be accessed by other commands using the memory pool; different commands can use the same name for a memory block without conflict.

### Example 1

Saves the active flow settings under the name *flows* in the memory pool.

```
5 flow save; 'flows'
```

### Example 2

Saves and restores the active flow settings over a subroutine call in a block unique to the unit. The block is automatically deleted when the unit is exited.

```
flow save; local
10 do routines, graph
flow restore; local
```

### Example 3

Makes the active flow settings the defaults for all subsequent units that are entered by a **jump** or **jumpop** branch.

```
15 flow save; default
flow restore; 'NAME' | local [; delete]
flow restore; default
```

Replaces the active flow settings with a previously saved set. Optionally, the named or **local** block can be deleted from the memory pool by using the **delete** modifier.

### 20 Example 1

Saves and restores the active flow settings over a library call. The library routine can alter the active flow settings as desired without affecting the calling program upon return. Alternately, the **flow save** and **restore** could be built into the library routine to provide a more easily used tool.

```
25 flow save; 'flows'
```

```
library routines, graph
flow restore; 'flows'
```

### Example 2

Re-activates the flow settings whose name is contained in the variable *setUp*. The memory  
5 block is then deleted.

```
flow restore; setUp; delete
```

```
flow delete; 'NAME' | local
```

Deletes a saved set of flow settings from the memory pool.

### Example

10 Deletes the *quiz* set of saved **flow** events from the memory pool.

```
flow delete; 'quiz'
```

```
flow reset
```

Deletes all named sets of flow settings from the memory pool. The **default** set of flow settings are unaffected.

15 **flow dir; keyBuffer [,length]**

Lists the keys for all the active **flow** events. The key inputs are returned as a sequence of 2-byte values (zero terminated if possible) into *keyBuffer*. These values can be used as input for **flow info** to obtain the full information about a **flow** event. The system variable **zflowcnt** holds the number of active **flow** events.

20 **Example**

Obtain the input key values for all the active flow settings. The inputs are returned as 2-byte values in a 50-element (maximum) array called *value*.

```
define local
```

```
value(50), 2
```

25 **define end**

```
flow dir; value(1), zflowcnt * 2 $$ read active flow keys
```

```
flow info; KEY; infoBufer [,length]
```

Returns the flow setting parameters for a specified key input value in the given buffer.

- 5 The maximum length of information returned is 22 bytes. The optional *length* argument can limit the number of bytes returned. An extensive coding example using **flow info** is found in lesson **TCSAMPLE** unit *i/flow*.

| parameter      | byte(s) | values                                                                                                          |
|----------------|---------|-----------------------------------------------------------------------------------------------------------------|
| branch type    | 1       | 0= not flow event<br>1= <b>jump</b><br>2= <b>jumpop</b><br>3= <b>do/library</b>                                 |
| lesson         | 8       | branch lesson name                                                                                              |
| unit           | 8       | branch unit name                                                                                                |
| range          | 1       | 0= current main unit only<br>1 = <b>default</b> event for new main units<br>2 = <b>router</b> (permanent event) |
| active         | 1       | 0 = at normal wait states<br>1 = <b>complete</b> (at end-of-unit)<br>2 = <b>break</b> (interrupt processing)    |
| execution mode | 1       | -2 = no change on branch<br>-1 = to binary<br>0 = to source<br>1 = to tpr                                       |
| window         | 1       | 0 = no change on branch<br>1 = window close<br>2 = window reset                                                 |
| base           | 1       | -1 = set =base on branch<br>0 = no change                                                                       |

#### System Default Flow Settings

While running your lesson, [SHIFT][F1],[F2] and [SHIFT][F2] are pre-defined by the

- 10 authoring system as:

```
flow jump; %F1; =exit; break; router
```

```
flow jump; %F2; =editor; break; router
```

```
flow jump; %f2; =system; break; router
```

Only [SHIFT][F1] is pre-defined by the student system as:

```
flow jump; %F1; =exit; break; router
```

- 5        These flow settings may be redefined, or deleted using **flow clear** with the **router** modifier. However, be sure to provide an alternate means to exit your lessons; otherwise a user could become stuck with no exit even to DOS.

To temporarily save, clear and restore both the active and default flow settings over or within a **library** call, do the following:

```
10 flow save; 'currents' $$ save active flow settings
 flow restore; default $$ restore defaults to active
 flow save; 'defsave' $$ save default flow settings
 flow clear; ; default $$ delete all but router settings
 ...
15 library routines, stuff $$ all settings but router can be changed
 ...
 flow restore; 'defsave' $$ read back saved default settings
 flow save; default $$ set them back as defaults
 flow restore; 'currents' $$ restore saved active settings
```

## 20        System Variables

### zreturn

The **save**, **restore**, **reset** and **delete** forms of the **flow** command, which use the memory pool, report on success or failure in **zreturn**. All other forms set **zreturn** to **ok** (-1). The major **zreturn** values are:

- 25        - 1        Operation successful
- 10        Name not found

18                   Unable to fill memory pool request

Miscellaneous

**zflowcnt**           Number of active flow settings

**zmaxflow**           Maximum number of flow settings allowed

5   **font**

      Selects fonts for text display.

---

|                |                                                                                               |
|----------------|-----------------------------------------------------------------------------------------------|
| <b>font</b>    | [ ' <i>LESSON</i> ',' <i>FONT</i> ' [; fontNumber   <b>standard</b> [; <b>noload</b> ] ]      |
| <b>font</b>    | [ ' <i>LESSON</i> ',' <i>FONTGROUP</i> ' [; fontNumber   <b>standard</b> [; <b>noload</b> ] ] |
| <b>font</b>    | ; fontNumber                                                                                  |
| 10 <b>font</b> | <b>standard</b> [; <b>standard</b> ]                                                          |
| <b>font</b>    | <b>info</b> ; infoBuffer [,length ]                                                           |

---

Description

      A font is a named block in a lesson. It contains character designs corresponding to some or all of the ASCII character codes 0 to 255. A font group is also a named block in a lesson. It  
15 contains a list of related fonts with different text attributes.

      The **text** command attributes of **size**, **bold**, **italic** and **narrow** interact with fonts and font groups. For a font, the appearance of the attributes is synthesized (except for **narrow**). When a font group is active, the system automatically selects the member font most appropriate for the text attributes enabled at any given time.

20       One font or font group is always designated as the **standard**. The standard font is the basis for character screen coordinates, even if some other font is currently selected for text display. For example, **at 5:10** specifies a screen position 5 standard character heights below the

top, and 9 character widths from the left. A font group appropriate for the current screen resolution is automatically designated as the standard when an **initial** or **screen** command is executed. However, this standard may be overridden with a different font or font group, thus altering the character grid.

- 5           A font or font group can optionally be associated with a reference number. This number alone can later be used to reselect the font.

The **status** command saves and restores all **font** and **text** parameters: the selected font or font group, the **standard** font, the font number table, and text attributes. A **status save;default** statement is required to save these parameters over a **jump** branch to a unit.

- 10           Fonts and font groups are kept in the memory pool. There is no need to explicitly delete fonts from memory; when space is required for other memory pool objects, they are automatically deleted and reloaded from disk if needed again.

- The system standard font groups exist in lesson **TCSTDFNT**. An additional set of decorative font groups is supplied in lesson **TCFONTS**. The Font Editor can be used to modify  
15 any of the fonts in these lessons, import fonts from other sources, or create custom fonts from scratch.

#### **font   ['LESSON',] 'FONT'**

- Selects a specific font from the current lesson or optionally from a named lesson. The font is brought from the disk to the memory pool and remains active until replaced by another **font**  
20 command or a **jump** branch to a unit which resets to the default font.

#### **Example 1**

The **initial** command causes all plotting parameters to be set to their system standard defaults including the **standard** font for the current screen resolution. Font *gothic* in the current lesson is then loaded and used for the following **write** text. Text attributes are then changed so

that the last **write** statement appears in a synthesized form of font *gothic*. The **zreturn** check indicates any system errors in loading the font from the disk. A **zreturn** check is recommended after any **font** command, but is omitted in the following examples to save space.

**initial**

```

5 write This text uses the system standard font.
 font 'gothic'
 if zreturn > -1
 . write Error «s,zreturn» loading Gothic
 endif
10 write This writing uses character designs in font Gothic.
 text size; 2
 text bold; on
 write This writing uses a bold and double size font
 synthesized from font Gothic.

```

## 15      **Example 2**

Selects font *bur48* from the decorative font library in lesson **TCFONTS**. This is the 48 dot high version of burlesk.

```

font 'tcfonTS', 'bur48'
write This text is using Burlesk character definitions.

```

## 20      **Example 3**

Selects the font named in the variable *fontVar* from the lesson named in the variable *fontLib*

```

font fontLib, fontVar
font ['LESSON'], 'FONTGROUP'

```

25      Activates a **font group** and selects a font from the group based upon current **text** attributes. Specific fonts can exist in a font group for all 72 combinations of the text attributes

size (1 through 9), **italic**, **bold**, and **narrow**. The **text** command (along with its embedded and uncover code forms) sets these attributes and therefore determines which font is selected from the group. If a font with the required attributes is not found in the group, the closest match is used, and the nonmatching attributes are synthesized if possible. Attributes that can be synthesized are

5 size (only 2 through 4), **italic**, and **bold**. The system variables **zfontret** and **zfontf** (see System Variables later) indicate how closely the current font selection from the group matches the text attributes currently in effect.

By looking at a **font** statement, it is not possible to tell whether a font or font group is referenced. However, the block's type is displayed on the Block Directory page.

#### 10 Example 1

The font group *mine* has 4 fonts in it specifically designed for size 1 and 2 in both normal and italic but not bold. Text attribute uncover codes in the write statements select for italic and bold. The italic comes from one of the designed fonts in the group while the bold is synthesized.

```
font 'mine'
15 text size; 1
write This normal and italic text comes directly from
 specifically designed fonts but bold is synthesized.
text size; 2
write This size 2 normal and italic text comes directly from designed
20 fonts while bold is synthesized starting from the size 2 normal
 and italic fonts.
```

#### Example 2

The size attribute causes the size 2 font to be chosen from each of the decorative font groups.

```
25 text size; 2
```



```
font 'tcfonts','burlesk'
write This writing uses the font group burlesk.
font 'tcfonts','opera'
write This writing uses the font group opera.
```

## 5 font standard

Selects the standard font or font group. This is one of the system standard fonts found in lesson **TCSTDFNT**, unless the standard font has been overridden as described in the following section.

### Example

```
10 font 'gothic'
write This text is in Gothic
font standard
write while this is in standard.
font ['LESSON',] 'FONT' ; standard
15 font ['LESSON',] 'FONTGROUP' ; standard
```

The optional keyword **standard** on a font selection causes the named font or font group to become the new standard, overriding the system standard font group. Any subsequent **font standard** statements select this new standard font or font group until a **jump** branch.

To make the new **standard** font selection permanent for an entire lesson, use **status save;default** to make the selection part of the default display parameters that are restored upon a **jump** branch. Then, only a subsequent **initial, screen, status restore;standard, or font standard;standard** statement restores the system **standard** font group in lesson **TCSTDFNT**.

System variables **zcharw** and **zcharh** report the width and height of the standard font at size 1. These values are the basis for character screen coordinates.

**Example**

Variable *typeface* contains the name of the font to activate; it becomes the **standard** font.

If the font is 32 pixels high and 32 pixels wide, then both the system variables **zcharh** and **zcharw** become 32. For **screen vga,medium** (480 pixels high and 640 pixels wide), the character coordinate grid now has 15 (480/32) lines and 20 (640/32) columns. The text for the **write** statement would appear at the graphic coordinates of  $x = 128 ((5-1)*32)$  and  $y = 416 (480 - (2*32))$ . This character grid remains in force until the **standard** font is replaced.

```
screen vga, medium
font typeface; standard
10 at 2:5
write Character position 5 on line 2.
font standard ; standard
```

Restores the system standard font group from lesson **TCSTDFNT**. This might be desirable if the standard font has been overridden earlier.

15 The lesson **TCSTDFNT** contains the system **standard** font groups and fonts, one named for each vertical screen resolution: the names begin with the letters **std** followed by the vertical resolution of the screen. For example, **std350** is for **ega,medium** screens, **std480** for **vga,medium** screens, and **std600** for **vga,high** screens. Whenever a **font standard;standard** or **initial, screen, or status restore;standard** statement is executed, the current screen resolution is used to select the system **standard** font group. Since it is a font group, the font selected from the group depends upon the current text attributes.

20

The system standard fonts can be changed by editing the fonts and font groups in lesson **TCSTDFNT** and then making a new binary to replace **TCSTDFNT.BIN**.

**font** ['LESSON',] 'FONT' fontNumber [;noload ]

**font** ['LESSON',] 'FONTGROUP' ; fontNumber [;noload ]

Selects a font or font group and assigns it a unique number from 1 to 35. Numbered fonts can be accessed by an uncover code sequence embedded in text. This allows switching between

5 fonts within a single **write** command, for example.

In the Source Editor, entering the sequence [CTRL][A],[F],[1] - [9] enters the uncover codes for the first 9 numbered fonts while the sequence [CTRL][A],[F],[A] - [Z] enters the codes for the numbered fonts 10 through 35. In student mode at an **arrow**, a similar sequence of codes can be used for switching fonts but the default uncover code sequence starts differently:

10 [CTRL][U],[M],[F],[A] - [Z].

Numbered **font** statements can be included in the **+editor** control block of a lesson so that text with embedded font selection sequences appears in the correct fonts during editing.

Font number assignments are saved and restored by the **status** command.

A single font or font group may be assigned more than one number by using multiple **font**  
15 commands. If this is done, any of the numbers assigned to the font can be used to select it.

However, a given number can be associated with only one font or font group at a time. The most recent assignment of a given font number overrides any earlier assignment.

The optional keyword **noload** is used to allow a font or fontgroup to have a font number association without actually loading the font into memory. This option can save disk read time at  
20 the start of a routine where multiple fonts need to be associated with font numbers. Later, the font will be automatically loaded as needed when referenced by its number embedded in **write** statements.

**Example 1**

Two numbered fonts are loaded. Uncover code sequences are used to switch between fonts within the text of the **write** statement. (Uncover code sequences become visible when display of hidden characters is turned on in the Source Editor.)

```

5 font 'gothic'; 2
 font 'geneva'; 3
 write This text is Geneva, ■f3 switches to Gothic, then .■f2 back to
 Geneva.

```

**Example 2**

10 In the **+initial** control block, the three numbered fonts are put into the default display **status** buffer. Any **jump** branch to a unit resets to these three numbered fonts so that they can be used through uncover codes in text of **write**, **pack**, etc. statements. If the **font** statements are also put into the **+editor** control block, any text with the font uncover codes (such as the **write** statement of this example) would be displayed in its chosen font during editing. The optional

15 keyword **noload** is used to avoid any possible startup delays.

```

* in the +initial control block
font 'tcfonts','geneva'; 1 ; noload
font 'tcfonts','poster'; 2 ; noload
font 'mine','firework'; 3 ; noload
20 status save; default
* in units throughout the lesson
write ■f1 Geneva, ■f2 Poster, ■f3 Fireworks
font ;fontNumber

```

Selects a font or font group that was previously assigned a number.

**Example**

Two numbered fonts are loaded. Several write statements switch between using the two fonts by referencing their numbers alone.

```
font 'gothic'; 2
5 font 'geneva'; 3
write This text is Geneva then
font ;2
write switches to Gothic then
font ;3
10 write back to Geneva.
```

**font info; infoBuffer [,length)**

Reads information about the selected font or font group into a buffer for the given length in bytes. If the length is not specified, the defined length of the buffer is used.

The following 256 bytes of information are available:

| System Data (100 bytes)                                | Bytes | Offset |
|--------------------------------------------------------|-------|--------|
| font lesson name                                       | 8     | 0      |
| font block name                                        | 8     | 8      |
| font group lesson name<br>(font lesson if font loaded) | 8     | 16     |
| font group block name<br>(font block if font loaded)   | 8     | 24     |
| font number (-1 =standard, 0=unnumberd)                | 1     | 32     |
| font group (-1=yes, 0=no)                              | 1     | 33     |
| character width                                        | 2     | 34     |
| character height                                       | 2     | 36     |
| baseline offset                                        | 2     | 38     |
| underline offset                                       | 2     | 40     |
| underline thickness                                    | 2     | 42     |
| underline gap                                          | 2     | 44     |
| shadow x offset                                        | 2     | 46     |
| shadow y offset                                        | 2     | 48     |
| italic angle (real)                                    | 4     | 50     |
| spacing decrement (0=no, 1=yes)                        | 1     | 54     |
| (reserved)                                             | 45    | 55     |

| Descriptive Information (156 bytes) | Bytes | Offset |
|-------------------------------------|-------|--------|
| font name                           | 16    | 100    |
| revision number                     | 1     | 116    |
| family                              | 1     | 117    |
| subclass                            | 1     | 118    |
| style                               | 1     | 119    |
| weight                              | 2     | 120    |
| points                              | 2     | 122    |
| horizontal resolution               | 2     | 124    |
| vertical resolution                 | 2     | 126    |
| (reserved)                          | 48    | 128    |
| copyright                           | 80    | 176    |

### Example

The copyright message for the **standard** font is displayed.

```

define local
5 infobuf,256
 . ,176 $$ skip other fields
 . copyrt,80 $$ copyright field
define end
...
10 font standard
 font info; infobuf
 at 10:1
 showa copyrt,80

```

### System Variables

15        **zreturn**

After a **font** command, **zreturn** indicates the success of loading a font:

- 1        Operation successful
- 0        Disk error (see **zdoserr**, **zedoserr**)
- 2        No font in group

- 4 File not found
- 10 Font name not found
- 15 File directory error - unrecoverable
- 18 Unable to fill memory pool request

## 5 **zfontret**

The system variable **zfontret** indicates how closely the current font matches the text attributes currently in effect.

### **zfontret** for a **font**:

- 1 Font loaded successfully
- 10 2 Unable to load font; **standard** font used
- 3 Unable to load **standard** font; charsets used

### **zfontret** for a **font group** (and updated when text attributes change):

- 2 Exact match of attributes; some synthesis used
- 1 Exact match of attributes
- 15 0 Partial match of attributes
- 1 No suitable match; base font used
- 2 Unable to load base font; **standard** font used
- 3 Unable to load **standard** font; charsets used

### **zfontf**

- 20 For **font groups** only, **zfontf** contains a bit field that reports on how the attributes are produced whenever a font is loaded or text attributes change causing the selection of another font in the group.

### **zfonff** bit      **meaning**

- 6 Bold matched in font group

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|   |    |                              |
|---|----|------------------------------|
|   | 7  | Italic matched in font group |
|   | 8  | Size matched in font group   |
|   | 16 | Narrow matched in font group |
|   | 22 | Bold synthesized             |
| 5 | 23 | Italic synthesized           |
|   | 24 | Size synthesized             |

The attribute may not match the request but also may not be synthesized; for example, if the font group only has bolded items, and the current attributes specify non-bolded, then bits 6 and 22 will both be off.

10      **Miscellaneous**

The following system variables are set after loading a font and are updated if appropriate when text attributes change:

|    |               |                                                           |
|----|---------------|-----------------------------------------------------------|
|    | <b>zfonth</b> | Character height and width of selected font               |
|    | <b>zfontw</b> |                                                           |
| 15 | <b>zcharh</b> | Character height and width of <b>standard</b> size 1 font |
|    | <b>zcharw</b> | (basis for the character coordinate system)               |
|    | <b>zfontb</b> | Baseline offset of selected font                          |
|    | <b>zcharb</b> | Baseline offset of <b>standard</b> size 1 font            |

**goto**

20      **Transfers execution to another unit or to the end of unit.**

---

|             |                                                                         |
|-------------|-------------------------------------------------------------------------|
| <b>goto</b> | <i>UNIT</i>   <b>q</b>                                                  |
| <b>goto</b> | <i>SELECTOR</i> ; <i>UNIT</i>   <b>q</b> ; <i>UNIT</i>   <b>q</b> ; ... |

---



**Description**

Allows the logical continuation of the current unit into another unit. **goto** switches execution to the specified unit but does not: erase the screen, clear the **do** return markers, change the main unit, or alter a help sequence.

5       The **q** keyword transfers execution to the end of the unit.

The **goto** command is considered by many as an obsolete programming method properly replaced by structured programming.

**if**

**Begins an if structure.**

---

10   **if**     *condition*

---

**Description**

Marks the beginning of an **if** structure. If the condition is true, any following indented code is executed. If the condition is false, execution continues with the next non-indented **elseif**, **else**, or **endif**.

15       An **if** structure is the main conditional structure in the TenCORE language. The commands which make up an **if** structure are:

**if**

**elseif** (optional, any number)

**else** (optional)

20       **endif**

The **if** structure begins with an **if** and ends with an **endif**. Commands to be executed when a particular condition is true are indented immediately following the **if**, **elseif**, or **else**. Indenting in

TenCORE consists of a period in the first character of the command field followed by 7 spaces (one tab stop in the source code editor). The command and tag of the indented command are then typed as usual.

In any **if** structure, only one set of indented commands is executed. The condition is checked on each **if** and **elseif** in succession. The indented commands beneath the first **if** or **elseif** that is true are executed and then control passes to the command after the **endif**. if none of the conditions on **if** and **elseif** are true, the indented commands following any **else** are executed.

## Examples

### Example 1

10        If the value of the variable *score* is over 75, the indented commands are executed.

```
if score > 75
.
. do goodfb
.
. jump endless
endif
```

15            **Example 2**

**elseif** and **else** commands are used in an if structure.

```

if right = 0 $$ user missed all questions
. do verybad
. jump helppg
20 elseif right < 5 $$ user got 1 to 4 right
. do notgood
. jump quiz
elseif right < 10 $$ user got 5 to 9 right
. do good
25 . jump review
else $$_user got more than 9 right
```

```

. do great
. jump endless
endif

```

### Example 3

5        An if structure is nested.

```

if wrong > 5 $$ user missed more than 5
. write You are making too many mistakes!
. pause
. if wrong > 10 $$ user missed more than 10
10 . . jump quit
. endif
endif

```

## image

Displays, captures and manages screen images.

---

|    |                 |                                                                 |
|----|-----------------|-----------------------------------------------------------------|
| 15 | <b>image</b>    | keyword                                                         |
|    | <b>plot</b>     | displays the specified image                                    |
|    | <b>save</b>     | captures all or part of the screen to the specified destination |
|    | <b>move</b>     | transfers an image between storage areas                        |
|    | <b>info</b>     | returns information about an image                              |
| 20 | <b>delete</b>   | deletes the specified image from the memory pool                |
|    | <b>reset</b>    | deletes all images from the memory pool                         |
|    | <b>compress</b> | turns compression of image data on or off                       |
|    | <b>palette</b>  | reads palette information from an image                         |

---

## Description

The **image** command is used to plot completed pictures onto the display, to capture pictures off the display or to move pictures between variables, memory pool blocks and disk storage locations (namesets, datasets, and lessons). Pictures are screen images that are: created in  
 5 image blocks by the Image Editor imported into image blocks from existing bit-map images created by "paintbrush" programs or a part of a screen that is directly captured and saved by either the Image Option -after pressing System Key [F2] or executing an **image save** command.

**image plot; from [ ;[ LOCATION] [ ;palette ] ]**

Plots the specified image at the same location it was saved from, unless a location is  
 10 specified. In either case, the current screen location is not changed. The display mode as set by the **mode** command is used in plotting the image. (See **mode** for additional information.) if the keyword **palette** is specified, the palette stored with the image is used. If **palette** is not specified, the palette is not changed. Images plot downwards from the specified location, which corresponds to the upper left corner of the image.

15 *from* keywords and syntax:

**block | b , 'NAME'**

Plots an image block from the specified lesson. If only the image name is specified, the current lesson is assumed.

**file | f [ ,record ]**

20 Plots from the attached dataset or nameset, starting at record 1 unless a starting *record* number is specified. In the case of a nameset, a valid name must have been previously selected with the **setname** command.

**memory** | **m** , 'NAME'

Plots from a memory pool block. The name may be a literal in single quotes, or occur in a variable.

**vars** | **v** , variable [ ,length ]

5               Plots from variables. The defined length of the variable is used unless a *length* is specified.

### Examples

**image**     **plot;block** , 'horse' ;20,100

\*           **block** "horse" at location 20,100

10

**image**     **plot;block** , 'library' , 'horse'

\*           **block** "horse" in file "library"

**image**     **plot;file**

15     \*           **currently attached file**

**image**     **plot;memory** , myimage

\*           name contained in the variable *myimage* from memory pool

**image**     **plot; vars** , picsave

20     \*           **image in variable** "picsave"

**image**     **plot;memory** , 'show' ;15:01;palette

\*           **plot using the palette stored with the image**

**image save; destination** [ ; [LOCATION] ; [LOCATION][ ;palette [variable]]]

25               Saves the area of the screen specified by the rectangular area to *destination*. If no display area is specified, the entire screen is saved. If the **palette** keyword is used, the current palette is stored with the image as well. If *variable* is given, only those colors specified in *variable* are

saved with the image. See **palette read** for the format of *variable*. The image is saved in a special compressed format in order to use as little storage as possible.

*destination* keywords and syntax:

**file** | **f** [ ,record ]

- 5           Saves to the attached dataset or nameset, starting at record 1 unless a starting *record* number is specified. In the case of a nameset, a valid name must have been previously selected with the **setname** command. The number of records required to save an image can be calculated as: (bytes + 255) \$div\$ 256.

**memory** | **m** ,*NAME*

- 10           Saves to a block in the memory pool. The name may be a literal in single quotes, or occur in a variable. If an image is already stored with the specified name it is replaced. Names in the memory pool created by **image** are independent of any names created with other commands. For instance, the **memory** command and the **image** command can both create a name in the memory pool called *cat* without causing a conflict. The **initial** command deletes all images from the
- 15   memory pool.

**vars** | **v** ,variable [ ,length ]

Saves to variables. The defined length of the variable is used unless a *length* is specified. The image may be truncated if the defined length of *variable* is insufficient

### Examples

20   **define**    **local**  
       **palblock**(16) ,6  
               **palslot**,2  
       **define**    **end**

```
image save;file;50,20;150,80
* save in attached file
```

```
image save;memory,'pic';0,0;99,99
5 *save in "pic", memory pool
```

```
image save;memory,'save';0,0;zxmax,zymax;palette,palblock(1),10
* save the first ten entries of the palette
```

**image move; from; destination**

10 Copies an image between a *from* and a *destination* when neither is the screen.

#### Example

```
image move;block,'abc';memory,'def'
* from "abc" in current file to block "def" in memory pool
```

15 **block** cannot be used for *destination*, since that would modify a running lesson source file. Also, if *destination* is **file**, then *from* can only be **memory** or **vars**.

**image info; buffer; from | last [; palette]**

**image info;bufter; display | d, LOCATION [;[LOCATION] [;palette]]**

Returns information about an image specified by *from*. The information is returned as 24 bytes in the specified buffer in the following fixed format:

|    |          |                                                    |
|----|----------|----------------------------------------------------|
| 20 | 1 byte:  | image type                                         |
|    |          | 0 = byte-oriented (CGA, EVGA, etc.)                |
|    |          | 1 = plane-oriented (EGA, VGA, etc.)                |
|    |          | 2 = text image                                     |
|    | 1 byte:  | bits per pixel (byte-oriented) or number of planes |
| 25 | 2 bytes: | bias from left of screen                           |

2 bytes:     bias from top of screen  
 2 bytes:     image width  
 2 bytes:     image height  
 4 bytes:     number of bytes used by image block  
 5     10 bytes     reserved

Bias, width, and height are given in pixels for byte- and plane-oriented images, and in character positions for text images.

Adding the **palette** keyword causes palette information to be included in the returned length of the image.

10     Additional *from* keywords and syntax exits for **image info**:

**display** | **d**, *LOCATION* [ ; [ *LOCATION* ] [ ; **palette** ]]

The image is taken directly from the screen. This form can be used to determine how much space a particular image on the screen will require, before creating a file to hold the image.

**last** [ ; **palette** ]

15     The last image processed by the **image** command.

### Example

```
define local
infovar,24
. type,1
20 bits,1
. xstart,2
. ystart,2
. xsize,2
. ysize,2
25 length,4
```



```

. ,10
define end
*
image info;infovar;display,50,50;100,100
5 at 2:1
write Image will require «s,length» bytes for storage
pause pass= all
created 'image1',(length+255) div 256
do zreturn;;error('created') $$ always check zreturn
10 image save;file;50,50;100,100

```

**image delete; 'NAME'**

Deletes the specified image from the memory pool.

**image reset**

Deletes all images from the memory pool.

15 **image compress; [ on | off ]**

Toggle image compression. Compressed images occupy less memory or disk space; non-compressed images in memory plot faster. The default is **on**.

**image palette; from ; buffer, entries**

Reads image palette entries into a buffer. The buffer must contain one or more 6-byte

20 palette entries in the form of:

slot (2bytes)

red (1 byte)

green (1 byte)

blue (1 byte)

25 intensity (1 byte)

The value of *slot* must be pre-set for each palette entry before executing **image palette**. The value of each slot will determine which palette slot's information is read into that entry. For example, if the value of *slot* for a particular entry is 8, the information for palette slot 8 will be read into that entry. If the values of *slot* are not set, slot 0 will be read into all the entries. Any

5 subset of palette entries may be read or written by setting appropriate slot values.

*entries* determines how many entries will be read.

### Example

Reads the palette information for the base 16 palette entries from the image in memory

block *test*:

```

10 define local
 pvar(16) ,6
 . slot,2
 . pred,1
 . pgreen,1
15 . pblue,1
 . intensty,1
 count ,2
 define end
 *
20 loop count <= 1, 16
 *must initialize slot numbers
 . calc slot(count) <= count - 1
 endloop
 *
25 image palette; memory, 'test';pvar(1),16

```

## Screen Compatibility

To be able to display an image from one screen on another screen, they must be of the same type. There are three types of image:

- graphics byte-oriented, such as the CGA, Hercules, MCGA, and EVGA
- graphics plane-oriented, such as the EGA, and VGA
- text

For graphics screens, the number of bits per pixel (byte-oriented) or number of planes (plane-oriented) must also be identical. Text images are compatible among all text screen types.

The characteristics of a given image can be determined using the **image info** command.

The following tables list the characteristics of the graphics screens currently supported by TenCORE:

| Byte-oriented Screens | Bits/pixel |
|-----------------------|------------|
| cga,medium            | 2          |
| cga,high              | 1          |
| hercules              | 1          |
| mcga,high             | 1          |
| mcga,medium           | 8          |
| evga                  | 8          |

| Plane oriented Screens | Number Of Planes |
|------------------------|------------------|
| ega                    | 4                |
| vga                    | 4                |

For example, in the byte-oriented group, the cga high, hercules, and mcga high images are compatible with each other. In the plane-oriented group, all listed screens are compatible with each other. *Caution: even though an image from one screen is compatible with another screen, it may look different on the other screen due to changes in aspect ratio.* For example, an ega high image plotted on a vga medium screen will be the same width, but only be about 73% of the original height.

**System Variable****zreturn**

|    |    |                                                       |
|----|----|-------------------------------------------------------|
|    | -1 | Operation successful                                  |
|    | 0  | Disk error (see zdoserr, zedoserr)                    |
| 5  | 1  | No file attached                                      |
|    | 2  | Block out of range                                    |
|    | 3  | Memory out of range                                   |
|    | 4  | File not found                                        |
|    | 5  | Image screen type doesn't match execution screen type |
| 10 | 8  | Insufficient disk records                             |
|    | 9  | No name in effect                                     |
|    | 10 | Name or block not found                               |
|    | 11 | Invalid type                                          |
|    | 16 | Invalid name                                          |
| 15 | 17 | Invalid image                                         |
|    | 18 | Unable to fill memory pool request                    |

**initial**

**Initializes the system to a standard state.**

---

**initial** [ nodetach ]

---

20      **Description**

Sets the system to a standard state. It is normally used when starting a lesson, as in a +**initial** control block, to set all system parameters to a known state.

The **nodetach** keyword prevents the currently attached file from being detached, and preserves any locks which are in effect for shared files.

The **initial** command performs the following command initializations:

### Display

|    |         |                    |
|----|---------|--------------------|
| 5  | window  | reset; noplot      |
|    | status  | restore; standard  |
|    | blink   | off                |
|    | color   | white              |
|    | colore  | black              |
| 10 | colorg  | black              |
|    | disable | cursor             |
|    | enable  | font               |
|    | font    | standard; standard |
|    | mode    | write              |
| 15 | origin  | 0,0                |
|    | rotate  | 0                  |
|    | scale   | 1,1                |
|    | text    | align; baseline    |
|    | text    | bold; off          |
| 20 | status  | save; default      |
|    | palette | init               |
|    | disable | absolute           |
|    | text    | delay; 0           |
|    | text    | direction; right   |

text increment; 0,0

text italic; off

text margin; wrap

text narrow; off

5 text reveal; off

text rotate; 0

text shadow; off,white

text size; 1

text spacing; fixed

10 text underline; off,foregnd

thick off

page 1

display 1

### **Input**

15 disable pointer

disable ptrup

enable area

area clear; default

area highlight; off

20 uncover %ctl"u"

force no lock

time clear \$\$ all but router

### **Branching**

flow clear;default

enable      break

base

### Disk

disk            -1            \$\$ search all drives for files

5      edisk            -1

detach            all

nsdirwr           -1            \$\$ always write nameset directory

### Judging

enable            arrow

10      okword            'ok'

noword            'no'

### General

memory           reset            \$\$ all but router

status            reset

15      area            reset

flow            reset            \$\$ all but router

perm            reset

image            reset

version                    \$\$ no version emulation

20      **Videodisc Overlay**

video            init

video            unitinit, on

**intcall**

**Calls a software interrupt.**

---

**intcall** number, pass, receive [ ;**extended** ]

number      interrupt routine to call

5      pass      data passed to the interrupt routine (8 or 20 bytes)

receive      data returned from the interrupt routine ( 8 or 20 bytes)

**extended**    forces the use of extended registers

---

**Description**

10      Calls the interrupt specified by *number*. In the non-extended form, the registers AX, BX, CX, and DX are set to contain the four 2-byte values from *pass*. Registers DS and ES are set to point to the global or local variables segment as appropriate for the *pass* variable; SI and DI are set to the offset within the segment. On exit from the routine, *receive* contains the four 2-byte values residing in the AX,BX,CX and DX registers. **zreturn** contains the low byte of the FLAGS register.

15      The **extended** keyword forces the use of the extended set of registers allocated to the 20 byte *pass* and *receive* variables in the following order:

AX,BX,CX,DX,SI,DI,BP,DS,ES,FLAGS

**Addresses**

20      The following system-defined function references are sometimes useful in setting or interpreting registers used with **intcall**:

**sysloc(global)** Segment address of global variables

**sysloc(local)** Segment address of the current unit's local variables



**varloc**(var) Offset address of the variable var

**absloc**(var) Absolute location of var within memory, expressed as a 4-byte offset with no segment. Corresponds to the segment:offset address as follows:

segment = absloc() \$ars\$ 4

5 offset = absloc() \$mask\$ h0f

absloc = ((segment \$mask\$ h0000fff) \$cls4\$ 4) + (offset \$mask\$ h0000fff)

### Example

Executes interrupt h12, which returns the memory size. The interrupt requires no input data, so the same variables are used for input and output.

```

10 define local
 regstrs,8
 . ax, 2 $$AX data
 . bx, 2 $$BX data
 . cx, 2 $$CX data
15 . dx, 2 $$DX data
 define end
 * call bios interrupt h12, "memory size determine" no input
 * parameters, so the same variables can be used for
 * input and output
20 *
 intcall h12, regstrs, regstrs
 at 5:5
 write You have «s, ax $imul$ 1024» bytes of memory.
```

## System Variable

**zreturn** contains the lower byte of the computer's internal flags register. The function reference **bit(zreturn,8)** can be used to test the carry (CY) bit, often set by software interrupts to indicate an error condition. See **intcall** online documentation for FLAGS register definition.

## 5 **jump**

### Branches to a new main unit.

---

|    |               |                                                                               |
|----|---------------|-------------------------------------------------------------------------------|
|    | <b>jump</b>   | <i>UNIT</i> [ (argument/16s) ]                                                |
|    | <b>jump</b>   | <i>SELECTOR; UNIT</i> [ (argument 16s) ]; <i>UNIT</i> [ (argument 116s) ];... |
|    | <b>jumpop</b> | <i>UNIT</i> [ (argument /16s) ]                                               |
| 10 | <b>jumpop</b> | <i>SELECTOR; UNIT</i> [ (argument/16s) ]; <i>UNIT</i> [ (argument/16s) ];...  |

---

### Description

The **jump** and **jumpop** commands branch to the specified unit making it the new main unit. Optionally, up to 16 arguments may be passed to the new main unit. All **flow** branch settings are cleared (except for **router** settings) and restored to their defaults.

15        A **jump** branch restores all plotting parameters to their default values (see **status**) and erases the screen (or window) to the **colore** color. All pointer areas are cleared and restored to their defaults.

      A **jumpop** (**jump on-page**) branch does not change plotting parameters, **area** settings or perform a screen erase.

20        The **flow** command with **jump** keywords performs similar functions. However, **flow** is a delayed event-driven branch while **jump** occurs immediately when the command is executed. **jump** also allows arguments while **flow** does not.

The **SELECTOR** form is described in the "Syntax Conventions". **jump** has an additional **q** (for quit) list entry form that if selected terminates further execution of the current unit. See Example 4.

Up to 16 arguments, separated by commas, can be passed with the branch. These are evaluated with the execution of the **jump** and their values are passed to next unit. A **receive** command in the next unit is used to accept the arguments. See the **receive** command for further information on argument passing and the system variables **zargs** and **zargsin** that are set when passing arguments.

### Examples

#### 10 Example 1

```
jump two
```

Branches immediately to unit *two* in the current lesson. The screen is erased and all defaults are re-established.

#### Example 2

```
15 jump rivers, <name>
```

Branches to the unit specified by variable *name* in lesson *rivers*.

#### Example 3

```
jumpop build (98.6, men+women, size)
```

```
...
```

```
20 receive temp, total, size $$ in unit build
```

Branches (without a screen erase) to unit *build* in the current lesson passing as arguments: the constant 98.6, the evaluation of the expression *men+women*, and the value in the variable *size*. In unit *build*, the **receive** statement accepts the passed arguments into variables. Since the screen is not erased with **jumpop**, unit *build* can add more to the existing screen display.

**Example 4**

```
jump x-2; one; two; three; q
```

This selective form of **jump** branches to unit *one* if *x-2* is negative, to *two* if 0, to *three* if 1 and quits executing any further commands in the current unit for values greater than 1.

5      **Generic Unit Names**

Generic branch names are provided for common **jump** destinations to new main units:

**=next**              The unit which physically follows the current main unit in the lesson. If none, the branch is ignored.

**=back**              The unit which physically precedes the current main unit in the lesson. If none, the branch is ignored.

**=first**              The first executable unit in the current lesson.

**=last**               The last executable unit in the current lesson.

**=main**               The current main lesson and unit as held in the system variables **zmainl,zmainu**.

15      **=base**              The main lesson and unit from which the last **base** modified **flow** branch occurred or as set by the **base** command. If none, the branch is ignored. The names of the current base lesson and unit are held in the system variables **zbasel,zbaseu**. Typically used for returning from a supplementary lesson sequence such as help to the main line of study.

20      **=editor**            The source editor (loaded with the current executing unit) if executed by the authoring system; ignored by the student executor.

**=exit**               The lesson exit as set by the **exitles** command and contained in the system variables **zexitl,zexitu**. Student users are typically branched back to their routing system such as the TenCORE Activity Manager or DOS

if none is present. An author testing a lesson is returned to the File Directory.

**=system** Opens the system options window with the calculator, image capture, cursor, etc. [F2] is normally loaded with this branch as a TenCORE system default during authoring; ignored by the student executor.

### Example

A learner proceeds to the next main unit if the question is answered correctly on the first try. If two or three tries are required, the current main unit is redone. For any other number of tries, the base unit pointer is set and the student is branched to a helping unit called *trouble*. In unit *trouble*, a **jump** to **=base** would return the learner to the base unit for another try at the question. This code would work equally well as part of the main unit or as a subroutine called by all the questions in the lesson.

```

if tries = 1
. jump =next $$ go on to next question
15 elseif tries < 4
. jump =main $$ re-do this unit
else
. base «zmainu» $$ set base to current main unit
. jump trouble $$ give learner extended help
20 endif

```

### library

Does a subroutine call to a binary unit.

---

```
library UNIT[([argument/16s][; return/16s])]
```

```
library SELECTOR; UNIT[([argument/16s][; return/16s])];...
```

---

### Description

A special form of the **do** command (which see) that does a subroutine call to an external binary library regardless of whether the calling unit is being executed in source or binary mode. The format is identical to **do** including the passing of arguments to and from the called unit. This command is used for calling completed routines or third-party TenCORE software that exists only in binary form. When a binary is made of a lesson, **library** and **do** work identically.

If the *calling* unit is executing in source mode (by running source code directly from the Source Code Editor), **library** switches to binary execution mode for the subroutine call. When returning from the *called* unit back to the *calling* unit, source mode execution is resumed. If the called library routine **jumps** to a new main unit, execution continues in binary mode and the "return to editing" key [F2] no longer operates.

See the **operate** command for a discussion of source and binary execution modes and how they can be explicitly controlled.

### loadlib

Loads a binary unit into the unit buffer.

---

**loadlib**     *UNIT*

**loadlib**     *SELECTOR; UNIT ; UNIT;*

---

### Description

Loads a binary unit into the unit buffer cache for execution by a subsequent **library** command. The unit is fetched from a binary file regardless of the type (source or binary) of the invoking unit or the status set by **operate**.

**loadlib** can be used to check for the existence of a unit before executing it, or to force units into memory. This can be useful for speeding up following sections of code, or for allowing the diskette on which the units reside to be removed.

**loadlib** should be used with caution: any non-executing unit can be purged from memory if space is needed for the execution of a unit.

### Example

Unit *copyfile* is pre-loaded from the binary copy of lesson *libfile*. Unit *copyfile* copies files from one diskette to another. Once loaded, the diskette containing lesson *libfile* can be removed.

```

10 loadlib libfile, copyfile
 * force binary unit copyfile into memory
 jump zreturn;; erroru $$ always check zreturn
 at 5:5
 write Now put the diskette to copy FROM in drive A and the diskette to
15 copy TO in drive B.

 Press Enter to begin the copy

 pause pass = %enter

 library libfile, copyfile $$ guaranteed to be in memory

```

### System Variable

```

20 zreturn

 -1 Operation Successful

 0 Disk error (see zdoserr, zedoserr)

 4 Lesson not found

 10 Unit not found
25 11 Invalid type

```

- 16 Invalid name
- 21 Conflict with another user's lock

## loadu

**Loads a unit into the unit buffer.**

---

5 **loadu**            *UNIT*

**loadu**            *SELECTOR; UNIT; UNIT;...*

---

### Description

Loads the specified unit from disk to the unit buffer cache without executing it. **loadu** can be used to load one or more units in advance to avoid later disk access delays, to check if a unit exists, or to load a unit from a diskette that is to be removed.

### Example

Unit *copyfile* is pre-loaded. Unit *copyfile* copies files from one diskette to another. Once loaded, the diskette containing the routine can be removed.

```

loadu copyfile $$ force unit copyfile into memory
15 jump zreturn;; erroru $$ always check zreturn
 at 5:5
write Now put the disk to copy FROM in drive A and the disk to copy
 TO in drive B.

20
 Press Enter to begin the copy.
pause pass = %enter
jump copyfile $$ guaranteed to be in memory

```



**System Variable****zreturn**

|    |                                    |
|----|------------------------------------|
| -1 | Operation Successful               |
| 0  | Disk error (see zdoserr, zedoserr) |
| 4  | Lesson not found                   |
| 10 | Unit not found                     |
| 11 | Invalid type                       |
| 16 | Invalid name                       |
| 21 | Conflict with another user's lock  |

10 **loop**

Starts a loop structure.

---

**loop**      [*CONDITION*]

**loop**      counter  $\Leftarrow$  start, end [ ,increment ]

counter    variable to serve as the index counter

15          start      starting value for *counter*

end        ending value for *counter*

increment increment (decrement)for the index counter

---

**Description**

20      Begins a loop structure ended by **endloop** used to repeat a series of commands for a specified number of times or while a condition is true. A **loop** structure can contain **reloop** and **outloop** commands (which see) at the same level of indentation. All other commands must be

indented. Loops may be nested within each other, but the range of the inner loop must be wholly within the range of the outer loop.

The assignment arrow ( $\Leftarrow$ ) distinguishes an ITERATIVE loop from a WHILE loop.

loop [ *CONDITION* ]

5 The code within the WHILE loop structure is executed for as long as the *CONDITION* is true. If no tag is given, repetition is continuous unless an exit is provided via **outloop**, **jump**, etc.

If a condition is present, its value is tested each time execution returns to the **loop** command. If the condition is true, a new iteration is begun; if false, the loop exits.

### Example

10 Plots a line of *X*'s on the screen using a WHILE loop.

```
at 5:1
loop zspace < 80 $$ while zspace is less than 80
. write X
endloop
```

15 loop counter  $\Leftarrow$  start, end [ ,increment ]

An ITERATIVE loop repeats for the number of times indicated by the controlling arguments. *counter* is assigned the value of *start*. Each time execution returns to the start of the loop, *increment* is added to *counter*. If *increment* is omitted, the default value is 1. If *increment* is a negative, the value of *counter* will decrease. If *counter* has passed the value of *end* (in whatever  
20 direction the loop is counting), the loop terminates.

### Example 1

```
loop index \Leftarrow 1,10 $$ loop from 1 to 10
. at index:4
. write index is «s,index»
25 endloop
```

**Example 2**

A WHILE loop is used to limit the horizontal plotting on the screen. The ITERATIVE loop plots a random number of X's with each iteration of the WHILE loop.

```

at 10:1
5 loop zspace < 80 $$ while zspace is less than 80
 . calc random ← randi(10)
 . loop index ← 1, random
 . . write X
 . endloop
10 . pause .5
 endloop

```

**memory**

**Manages memory pool data storage.**

---

**memory keyword;...**

|    |                 |                                                   |
|----|-----------------|---------------------------------------------------|
| 15 | <b>create</b>   | allocates new memory block                        |
|    | <b>read</b>     | transfers data from memory block to variables     |
|    | <b>write</b>    | transfers data from variables to memory block     |
|    | <b>exchange</b> | exchanges data between memory block and variables |
|    | <b>move</b>     | transfers data between memory blocks              |
| 20 | <b>delete</b>   | deletes named memory block                        |
|    | <b>reset</b>    | deletes all memory blocks                         |
|    | <b>rename</b>   | changes name of memory block                      |
|    | <b>resize</b>   | changes size of memory block                      |

## 300

|              |                                               |
|--------------|-----------------------------------------------|
| <b>info</b>  | returns block information in system variables |
| <b>total</b> | changes total size of memory pool             |

**Description**

Provides access to the memory pool. Memory in the pool is allocated by named blocks.

5 Data in a variable (buffer) can be written and read from these named memory pool blocks. The system automatically manages the memory pool as blocks are created, deleted, and resized. The main memory pool consists of all unused DOS memory below 640 Kilobytes. Secondary(virtual) memory such as expanded(EMS), extended(XMS), and disk memory is used to expand the main memory pool.

10 Most **memory** command calls should be followed by a **zreturn** check to verify successful performance.

The **initial** command deletes all memory blocks. An execution error also deletes all blocks, and restores the size of the memory pool to the size at startup.

The memory pool is used by the commands: **memory**, **image**, **window**, **status**, **area**,  
15 **flow**, **font** and **perm**. Memory blocks are tagged as belonging to a specific command type at creation and cannot be accessed by other commands using the memory pool. Different commands can use the same name for a memory block without conflict.

**memory create; 'NAME ',size [; fixed | router | temporary ]**

Creates a named zero-filled block of the given size in the memory pool. When a block is  
20 allocated in the memory pool, its size is rounded up to a multiple of 16 bytes. In addition to its rounded-up length, each memory block uses an additional 16 bytes in the pool.

The optional modifier **fixed** pins the block to a fixed place in memory whose address is found in the system variable **zmstart**. Fixed blocks should be avoided except where absolutely

required since they degrade the operation of the memory pool. An example use of a fixed block is as a communication buffer with an external program.

Normally, a memory block is deleted by **initial** or **memory reset** unless the optional keyword **router** is present. A router modified memory block can only be deleted with an explicit **memory delete; 'NAME'** or **memory reset ; router** statement. **router** modified memory blocks are accessible from any domain and are not deleted by the deletion of the domain in which they were created.

A **temporary** modified memory block is deleted automatically when the system requires additional memory pool space: it is useful for holding data that can be regenerated when necessary.

The modifiers are mutually exclusive: only one can occur in a **memory create** statement.

### Example 1

Creates a 1000-byte memory block called *temp* in the memory pool. A jump to unit error occurs if an error such as insufficient memory occurs.

```
15 memory create; 'temp',1000
 jump zreturn;;error
```

### Example 2

Creates a 200-byte **fixed** memory block using the name contained in the 8-byte variable *name*.

```
20 memory create; name,200; fixed
 jump zreturn;;error
```

**memory write; 'NAME ',offset; buffer; length**

Transfers data to the named memory block starting at the given offset from a variable buffer for the given length of bytes. All offsets in memory blocks start at 0: to reference the beginning of a memory block, use an offset of 0.

**Example**

Transfers 8 bytes from variable *score* to memory block *results*, starting 32 bytes past the beginning (0) of block *results*. Jump to an error routine if something goes wrong.

```
memory write; 'results',32; score; 8
```

```
5 jump zreturn;;error
```

```
memory read; 'NAME ',offset; buffer; length
```

Transfers data from the named memory block starting at the given offset to a variable buffer for the given length of bytes.

**Example 1**

10 Transfers 256 bytes of data from the beginning (offset 0) of memory block *info* to the buffer *infobuf*. Jump to an error routine if something goes wrong.

```
memory read; 'info',0; infobuf; 256
```

```
jump zreturn;;error
```

**Example 2**

15 All global variables are saved and restored over a call to a library subroutine. First, a memory block called *saveVars* is created. The global variables are transferred to this memory pool block. A library routine is called that may change the global variables as desired. Finally, the global variables are restored.

```
define global
```

```
20 globals=29696 $$ assume default global space (29 Kilobytes)
```

```
varBlock,globals,block
```

```
define end
```

```
*
```

```
memory create; 'savevars',globals $$ create globals block
```

```
25 jump zreturn; ; error
```

```
memory write; 'savevars',0; varBlock; globals $$ save globals
```

```
jump zreturn;;error
```

```
...
```

```
zero varBlock,globals $$ perhaps zero all globals
```

```
library routines,graph $$ can use all globals
```

```
5 ...
```

```
memory read; 'savevars',0; varBlock; globals $$restore globals
```

```
jump zreturn;;error
```

**memory exchange 'NAME ',offset; buffer; length**

Exchanges data between the named memory block starting at the given offset, and a

10 variable buffer for the given length in bytes.

#### Example

```
memory exchange; block,0; buf(i); 12
```

Swaps 12 bytes of data between the start of the memory block named in *block* and the array buffer starting at *buf(i)*.

15 **memory move; 'FROMNAME ',offset; 'TONAME ',offset; length**

Moves data directly between memory blocks.

#### Example

```
memory move; 'databuf',0; 'backup',3; 256
```

Transfers 256 bytes of data from the beginning of memory block *databuf* to memory  
20 block *backup* starting at offset 3.

**memory delete; 'NAME '**

Deletes a named block from the memory pool.

**memory reset [;router]**

**memory reset** deletes all memory blocks except those created with the **router** modifier.

25 Using the optional modifier **router** causes all memory blocks to be deleted including those created with the **router** modifier.

**memory rename; 'NAME','NEWNAME'**

Renames a memory block

**memory resize; 'NAME',size**

Changes the size of the named memory block. The memory block cannot be a **fixed** block.

- 5 If the new size is larger, zeroed bytes are added to the end. if the new size is smaller, bytes are removed from the end. In either case, the remaining data is unchanged.

**memory info; 'NAME'**

Sets the system variable **zmlength** to the named block's size in bytes (or 0 if the block does not exist). If the block is of **fixed** type, sets the system variable **zmstart** to the block's  
10 absolute address in the memory pool. This command can be used to check whether a memory block of a certain name exists.

### Example

**zreturn** checks are used to verify the existence of the memory block whose name is contained in the 8-byte variable *test*. If in the memory pool, its length and address (0 if not of  
15 **fixed** type) are displayed.

```
memory info; test
if zreturn $$ test for success (-1)
. write length= «s,zmlength» address= «s,zmstart»
elseif zreturn=10
20 . write Name does not exist
else
. write Other Error
endif
```



**memory total; size**

Changes the size of the memory pool. If the size is increased, additional memory is requested from DOS; if decreased, the unused memory is returned to DOS. By default, all unused DOS memory (below 640K) is allocated to the memory pool; therefore it is not possible to

5 increase the memory pool size unless it has been specifically limited by command line options when starting TenCORE. if a memory-resident program has been loaded after TenCORE, the memory pool size cannot be increased.

**Secondary Memory Pool**

When space runs out in the memory pool, existing blocks in the pool are automatically

10 moved to the secondary memory pool to make room for new blocks. The secondary memory pool can be any or all of the following: expanded (EMS) memory, extended (XMS) memory, or disk. If more than one memory type is available, first expanded (EMS), then extended (XMS), and finally disk is used.

When starting TenCORE, a default amount of available EMS, XMS, and disk space is

15 automatically allocated to the secondary memory pool. If desired, the amount of each can be set upon system startup.

When a secondary memory pool is available, the maximum size of a block is still limited by the size of the main memory pool; however, more memory pool blocks can be created since existing blocks can be moved to the secondary memory pool.

20 Creating **fixed** memory pool blocks limits the maximum size of further memory pool blocks because they cannot be moved to secondary memory. In general, use of **fixed** memory blocks is not recommended.

**System Variables****zreturn**

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The **memory** command sets **zreturn** as follows:

|      |                                                                                                                       |
|------|-----------------------------------------------------------------------------------------------------------------------|
| 1    | Operation successful                                                                                                  |
| 3    | Variable reference out of range                                                                                       |
| 6    | Duplicate name                                                                                                        |
| 5 10 | Name does not exist                                                                                                   |
| 11   | Invalid type (resize of fixed block)                                                                                  |
| 16   | Invalid name                                                                                                          |
| 18   | Insufficient memory in pool (create and resize keywords) or<br>insufficient DOS memory to add to pool (total keyword) |

#### 10 Miscellaneous

The following system variables are set after any **memory** command which references a memory block name (except **delete**):

|                 |                                                                              |
|-----------------|------------------------------------------------------------------------------|
| <b>zmlength</b> | Size, in bytes, of last referenced memory block                              |
| <b>zmstart</b>  | Absolute address of last referenced memory block if fixed;<br>15 otherwise 1 |

The following system variables provide information about the TenCORE memory pool:

|                 |                                                                                                   |
|-----------------|---------------------------------------------------------------------------------------------------|
| <b>zrmem</b>    | Largest possible size for a new memory block that is not <b>fixed</b>                             |
| <b>zfmem</b>    | Largest possible size for a new <b>fixed</b> memory block                                         |
| <b>zmem</b>     | Size of memory pool                                                                               |
| 20 <b>zxmem</b> | Amount of extra DOS memory which could be added to the<br>memory pool (with <b>memory total</b> ) |

**mode**

Controls how graphics, text and images are plotted on the screen.

---

**mode**      *mode*

**mode**      *SELECTOR; mode; mode;...*

5    **write**      «**mode** | *m, mode*»

The *mode* plotting keywords are:

**write**      use foreground color

**erase**      use background (erase) color

**rewrite**    use foreground color, erase character background

10   **inverse**    use background (erase) color, plot character background

**noplots**    simulates plotting without affecting the display

**xor**        use foreground color with *EXCLUSIVE OR* on existing display

**add**        use foreground color with *OR* on existing display

**sub**        use inverted foreground color with *AND* on existing display

---

15      **Description**

Controls how graphics, characters and images are put on the display screen. Each of these three types of objects has its own structure and interaction with the mode and color commands.

Graphic objects such as **draw** and **circle** consist of the dots defining the object; they use the foreground color when plotting on the screen. Characters consist of foreground dots that define a

20    character and the remaining background dots of the character cell: the foreground and

background dots perform different tasks in the various modes using the foreground and erase

colors. Images consist of a rectangular area of already colored dots and do not use the

foreground or background colors. However, a dot of color black (palette slot 0) in an image can be used for transparency to any pre-existing display.

For text-only display screens, individual dots are not addressable: only whole character positions can be changed which limits the functionality of many of the modes. Text-only mode  
5 operations are discussed separately at the end.

The mode is reset to the default mode upon a **jump** branch to a unit. The initial default setting for mode is **write**. This can be changed through use of the status **save** statement.

A change in mode through an embedded **mode** command in a **write** statement does not extend beyond the **write**: upon finishing a write, the mode is restored to its value as at the start of  
10 the **write**.

#### **mode write**

Plots graphics and character dots in the foreground color. Images are plotted with their designed colors. Character backgrounds and the slot 0 color of images are transparent to any existing display.

#### 15 **mode erase**

Erases graphics and character dots to the background (erase) color. Images are erased as for mode sub.

#### **mode rewrite**

Plots graphics and character dots in the foreground color. Character backgrounds are  
20 erased to the background (erase) color. Images are plotted entirely with their designed colors including the slot 0 color.

#### **Example**

A "count-down" is performed counting down from 10 to 0 followed by a "BANG!".

**mode       rewrite**

```

loop count ← 10,0,-1
. at 10:25
. showt count,2
. pause 1
5 endloop
at 10:25
write BANG!

```

### mode inverse

Plots graphics and character dots in the background (erase) color. Character background  
 10 is plotted in the foreground color. Images first have all colors inverted to their bit-wise  
 complements and then are plotted entirely including color slot 0.

### mode noplot

Simulates plotting without altering the screen. The screen location and all plotting  
 attributes except **mode** are updated as though real plotting had occurred.

### 15 Example

The length of a line of text is first determined using **mode noplot** and put into the variable  
*length*. This is done by setting the screen x position to 0 by an **at**, plotting the text in **mode**  
 noplot, then getting the ending position found in the system variable **zx**. The text is then really  
 plotted centered on the screen or display window. This is done in the last **at** statement by halving  
 20 the display width (**zxmax** /2) then moving back by half the text width (*length*/ 2).

```

mode noplot$$ do not affect screen
at 0,100 $$ start at x=0
write Handling Snakes $$ simulate plotting of text
calc length ← zx $$ the system variable zx gives
25 * $$ length of text
mode write $$ set to standard plotting mode

```

310

```

at zxmax/2 - length/2,100 $$ set start of text
*
 $$ for centering
write Handling Snakes
mode xor

```

- 5        Graphics, character dots and images are logically *EXCLUSIVE OR* combined with any existing display. Plotting the same material twice on the screen in the same location in this mode returns the display to its original composition.

### Example

The word "ORBIT" is made to animatedly rotate around the center of the screen. If

- 10    "ORBIT" runs through some background graphics, it would do so without altering the background. *rad* is defined as a real variable and holds the radian for the sin/cos calculations.

```

screen vga
calc rad ← 0
mode xor $$ switch to EXCLUSIVE OR plotting
15 loop
. at sin(rad)*100 + 320, cos(rad)*100 + 240
. write ORBIT
. pause .01
. at sin(rad)*100 + 320, cos(rad)*100 + 240
20 . write ORBIT
. calc rad ← rad + .05
endloop
mode add

```

Graphics, character dots and images are logically *OR* combined with any existing display.

**mode sub**

Graphics, character dots and images are color inverted and then logically *AND* combined with any existing display.

**Text-Only Hardware Screens**

5       The modes **write**, **erase**, **rewrite** and **inverse** work as expected changing the character foreground and background colors as appropriate. The logical modes **xor**, **add** and **sub** change the foreground character color as explained already. However, **xor** plots characters only where blank (space) characters already exist on the screen and otherwise erases characters from the screen.

10       **System Variable**

**zmode**   Holds the current plotting mode

0       inverse

1       rewrite

2       erase

15       3       write

4       noplot

5       xor

6       add

7       sub

20       **move**

Moves bytes of data from a literal or variable into a variable.

---

move   from, to, length

---

**Description**

Moves the specified number of bytes from one location to another. if both *from* and *to* are variables, they may overlap, and the length of data moved may exceed the defined length of either variable. The **move** command is extremely fast.

5 **Example**

Moves *rec(2)* through *rec(5)* down one record.

```

define local

reclen = 256 $$ TenCORE data record is ALWAYS 256 bytes
rec(6),reclen $$ array of six records
10 define end
*
move rec(2), rec(3), 4*reclen $$ move the records down

```

**nextkey**

Advances system key input buffer and variables.

---

```

15 nextkey [keyword]

 blank advances key buffer and updates zinput
 test updates zinput without advancing key buffer clear
 clears the key input buffer
 flags updates zinputf and zkeyset
20 pointer updates zinputx, zinputy and zinputf, sets zinput to %ptrinfo

```

---

**Description**

**nextkey** reads pending keys from the system key input buffer. Input is normally buffered until the end of a main unit, a **pause**, an **arrow**, or a **no judgment** is encountered. **nextkey** checks



the input buffer immediately, without waiting for one of these waiting states. The blank tag form copies the next available key from the buffer into **zinput** and removes the key from the buffer

If the key buffer is empty, the system variable **zinput** is set to zero.

Encountering a **nextkey** does not activate current **flow** settings.

## 5 **nextkey**

Updates **zinput**, **zinputf**, and **zkeyset** with the next available key in the input buffer, removing the pending key from the buffer. If the pointer is enabled, **zinputx** and **zinputy** are also updated.

### **nextkey test**

- 10 Updates **zinput**, **zinputf**, and **zkeyset** like the blank-tag form, but does not remove the pending key from the key buffer

### **nextkey clear**

Clears the input buffer of all pending keys. Does not clear **zinput**.

### **nextkey flags**

- 15 Updates **zinputf** and the left-most byte of **zkeyset**, and zeroes the right-most byte of **zkeyset**. No change is made to **zinputx** and **zinputy**.

### **nextkey pointer**

Updates **zinputx**, **zinputy** and **zinputf**. Sets **zinput** to **%ptrinfo**.

### **Example**

- 20 The question "What goes meow?" is shown as an animated billboard at the top of the display. When the user presses a letter on the keyboard, the animation stops and the letter appears at the following arrow. The variable **x** is defined as a 2-byte integer.

```
margin wrap $$ wrap around screen
mode rewrite $$ replace any underlying text
```

314

```

calc x ← zxmax / 2 $$ start in middle of screen
nextkey clear $$ clear any pending keys
nextkey $$ clear zinput also
*
5 loop zinput = 0 $$ loop while no input keys
. at x,zymax-20 $$ near top of screen
. write What goes meow? $$$ text will move to left in loop
. calc x ← x - 1 $$ move starting x to left 1 pixel
. calcs x < 0; x ← zmax;; $$ check for screen wrap
10 . nextkey test $$ update zinput
endloop
*
arrow 10,zymax-40
answer cat
15 endarrow

```

### System Variables

|    |                |                                                                                     |
|----|----------------|-------------------------------------------------------------------------------------|
|    | <b>zinput</b>  | 0 no input<br>1-255 character value of last keypress<br>>255 non-character keypress |
| 20 | <b>zinputf</b> | Flags for the input in <b>zinput</b>                                                |
|    | <b>zkeyset</b> | Flags and scan code for the input in <b>zinput</b>                                  |
|    | <b>zinputx</b> | X-coordinate of the pointer device for the input in <b>zinput</b>                   |
|    | <b>zinputy</b> | Y-coordinate of the pointer device for the input in <b>zinput</b>                   |

**nocheck**

Cancels subroutine call argument count checking.

---

**nocheck return | receive**
**nocheck return , receive**

5    **return**                      Turns off checking of argument counts for **return** commands

**receive**                      Turns off argument count checking for **receive** commands

---

**Description**

Disables the automatic checking which is done on **return** and/or **receive** commands to insure that the correct number of arguments is being passed.

10            **nocheck** allows any number of tags to be present in **return** or **receive**, regardless of the number of arguments specified by the *calling* (**do**, **library**, or **jump**) command.

**nocheck** must be in the same unit as the **return** and **receive** commands to be affected (the *called* unit).

**operate**

15            Switches between different execution modes.

---

**operate    mode**
**operate    *SELECTOR*; mode; mode;..**

The *mode* keywords are

**source**      execute subsequent units from *.SRC* files

20    **binary**      execute subsequent units from *BIN* files

**tp**            execute subsequent units from *.TPR* files

---

## Description

Sets the mode of operation, **source**, **binary** or **tp**, for system file execution. When a command executes which requires the system to access a unit, the mode of operation determines whether it looks for the unit in a **source** (*.SRC*), **binary** (*.BIN*) or **producer** (*.TPR*) file. The default is to access the same type of file as the current unit was loaded from.

The **operate** command remains in effect until it is changed by another **operate** command, a **library** command, an **error** branch, or execution of a **flow** with an **operate** tag.

If the mode is changed by a **flow do**, it is restored upon completion of the **do** sequence. If the mode is changed by **flow jump**, it is not restored.

Executing **operate source** in the student executor generates execution error 11, "invalid argument value".

**error** saves the mode of operation at the time the command is executed (at the time the branch pointer is loaded). When the **error** branch is taken, the mode of operation is reset to the mode which was in effect at the time the pointer was loaded.

## Interaction with library Command

Execution of **library** temporarily sets the mode of operation to binary. if execution returns normally from the binary unit, the original mode of operation is restored.

However, two things can prevent restoration of the original mode of operation:

- entering a new main unit from a library unit, in which case no return from **library** occurs and binary operation continues.
- executing an **operate** while in a library unit, in which case no restoration of the mode of operation is performed on return to the calling unit. If the calling unit was itself called by a **library**, the mode of operation is restored on return to that calling unit.

**origin**

Sets the origin for the display coordinate system.

---

**origin** [*LOCATION*]

---

**Description**

- 5 Moves the origin for the coordinate system from the default location (0,0) to the specified location. All subsequent display commands are positioned relative to the specified origin.

The origin is set to (0,0) at the start of each new main unit. This can be changed using **origin** followed by **status save; default**.

A blank-tag resets the origin to 0,0

10 **Example**

Displays a box inscribed with an x on three different areas of the screen.

**origin**

```
origin 120,70 $$ set origin for first box and x
```

```
do xbox $$ plot it relocated
```

15 

```
origin 160,100 $$ second box
```

```
do xbox
```

```
origin 200,130 $$ third box
```

```
do xbox
```

**xbox**

- 20 \*
- this unit draws a 4-pixel thick box with an "x" inside it
- it is normally plotted in the lower left corner of the
- display
- \*
- \*

```
box 0,0;20,20;4 $$ draw the box
```

**draw** 0,0;20,20;;0,20;20,0 \$\$ followed by x

### System Variables

**zoriginx** Absolute X-coordinate for the current origin

**zoriginy** Absolute Y-coordinate for the current origin

## 5 **outloop**

**Exits a loop structure from any point within the structure.**

---

**outloop** [*CONDITION*]

---

### Description

Provides an exit from any point within the loop structure. If the tag is blank or the condition is true, **outloop** goes to the command following the associated **endloop**. If the condition is false, no action is taken and execution continues with the next command within the loop structure.

**outloop** always appears at the same indentation level as the loop structure to be exited, regardless of any other indented structures surrounding the **outloop**.

## 15 **Example**

```

define local
counter, 2 $$ counter
define end
local
20 *
at 5:3
write Press Enter to increment the counter, or
 Esc to exit the loop.
calc counter <= 1

```

```

loop
. at 8:3
. erase 50
. write The counter value is «show, counter».
5 . pause pass= %escape, %enter
outloop zinput = %escape $$ exit if Esc is pressed
. calc counter ← counter + 1
endloop
*
10 at 10:3
write You exited the loop!

```

## pack, packz

## packc, packzc

Places text string into buffer.

---

|    |                        |                                                                                       |
|----|------------------------|---------------------------------------------------------------------------------------|
| 15 | <b>pack</b>            | buffer; [ length ]; <i>TEXT</i>                                                       |
|    | <b>packz</b>           | buffer; [ length ]; <i>TEXT</i>                                                       |
|    | <b>packc</b>           | <i>SELECTOR</i> ; buffer; [ length ]; <i>TEXT</i> ; <i>TEXT</i> ;...                  |
|    | <b>packzc</b>          | <i>SELECTOR</i> ; buffer; [ length ]; <i>TEXT</i> ; <i>TEXT</i> ;...                  |
|    | <b>buffer</b>          | A variable into which a text string is placed.                                        |
| 20 | <b>length</b>          | An optional variable that is assigned the number of characters placed into the buffer |
|    | <b><i>TEXT</i></b>     | The text string to be placed into the buffer.                                         |
|    | <b><i>SELECTOR</i></b> | An expression used for selecting one of the <i>TEXT</i> cases.                        |

---

## Description

Places a text string into the given buffer and if a length variable is specified, returns the number of characters actually stored. If the defined buffer is longer than the text string, the **pack** form leaves the extra bytes unchanged while the **packz** form zeroes them. A **c** (conditional) suffix on the command denotes the *SELECTOR* form.

The text string can contain embedded **show**-type commands such as **show**, **showt**, and **showa**. If the text extends beyond one line, a carriage return (code 13) is packed into the buffer before each additional line. If the text string continues over blank lines, multiple carriage returns are included. If the length of the text string is not required, use a null argument for length.

The **pack** commands do not perform bounds checking: characters being packed can overrun a buffer and overwrite subsequent variables or cause an execution error if they extend beyond defines. The maximum possible length of a text string must be allowed for.

## *SELECTOR* Delimiters

The delimiter following the length argument is used by **packc** and **packzc** to delimit the text strings for each case. The following delimiters are valid:

comma ,

semicolon ;

colon :

end-of-line ↵

universal delimiter |

Two consecutive delimiters indicates a null tag; nothing is packed into the buffer for the corresponding value of *SELECTOR*. If a delimiter other than end-of a line is being used, a single string can span more than one line, in which case a carriage return is packed in for each end-of-line encountered.



## Null Codes

Any null characters (code 0) in an embedded **showa** command are skipped; the null characters do not appear in the resulting string. Null characters can be forced into a packed string by using an embedded **showv** command with a variable that contains the null characters.

### 5 Examples

#### Example 1

Puts three lines of text into the buffer *lines*. They are separated by carriage return codes in the buffer. *count* is set to the length of the string packed. The **showa** statement would display the three line text string.

```
10 pack lines;count;The first line of text.
 The second line of text.
 The last line of text.
showa lines,count
```

#### Example 2

15 Embedded commands are used to include the name in buffer *name* and integer in variable *age* within the text string being packed into buffer *introbuf*. Any extra space in *introbuf* is zero filled. No length argument is used. The **showa** statement would display a message such as "My name is Alex. I am 23 years old." Any following zero codes in *introbuf* are skipped by the system plotting routines.

```
20 packz introbuf;;My name is «a,name». I am «s,age» years old.
showa introbuf
```

#### Example 3

Based on variable *number*, the text *negative*, *zero*, or *positive* is conditionally placed into *textBuf* setting *count* to the number of characters transferred. *End-of-line* is used as the

25 *SELECTOR* delimiter. Unused space in *textBuf* is zero filled.

322

```

packzc number;textBuf;count
 negative
 zero
 positive

```

#### 5      **Example 4**

The buffer *textDate* is set to a character string with today's date (for example "January 1, 1993"). The variable *temp* is used to hold the month until it is packed into *textDate* along with the day and year. Note the three null arguments on the **packzc** command: the first indicates no length information is required; the next two handle the *SELECTOR* negative and zero cases which are

10 not possible with *month*.

```

define local
today, 4
. year, 2
. month, 1
15 . day, 1
temp, 9
textDate,20
define end
*
20 date today $$ obtain the system date information
*
packzc month;temp;;;January;February;March;April;May;June;July;August;
 September;October;November;December
*
25 packz textDate;; «a,temp» «s,day», «s,year»
*
at 5:10

```

```
showa textDate $$ display today's date
```

## page

Selects the hardware screen page to use for plotting and display.

---

```
page showpage [,writepage]
```

```
5 showpage page number to display
 writepage page to plot on
```

---

### Description

Some display hardware has several separate, complete displays called *pages*. The **page** command is used to control them.

10        The one argument form of **page** changes the active display page to the one specified. The contents of that page are displayed immediately and all further plotting occurs on that page.

The two argument form causes the page given first to be displayed while the page given second is used for all further plotting activity. This allows the program to construct a new, hidden page in memory while the user is viewing the displayed page.

15        Entering a new main unit erases only the page selected for plotting.

The number of pages available depends on the display hardware being used, the display memory available, and the screen resolution selected. The system variable **zmaxpage** contains the number of pages that the current screen supports.

### Example

20        Animates an image named *fish* in **mode xor**. Because redisplaying an object in **mode xor** removes it cleanly from the display, mode **xor** is used when an animated object must pass over other objects without destroying them. Without **page**, **mode xor** animations usually show too much flicker to be useful.

Page 1 is used to show the image at odd x-locations 201, 203, 205, etc.

Page 2 is used to show the image at even x-locations 202, 204, 206, etc. By alternating pages, the image is made to appear at 201, 202, 203, 204, 205, 206, etc.

```

screen ega, graphics, medium, color

5 define local

 x, 2

 define end

 * set mode and load image into memory

 mode xor

10 image move; block, 'fish'; memory, 'fish'

 * display the first image on page 1

 image plot; memory, 'fish'; 201,100

 * while displaying page 1,

 * erase page 2 and put the next image on it

15 page 1, 2

 erase

 image plot; memory, 'fish'; 202,100

 loop x <= 201,400

 . * show page 2 while changing the display on page 1

20 . * ...re-display (thus removing) the old fish on page 1

 . * ...and display a new fish 2 pixels to the right on page 1

 . * then increment x-location counter by 1

 . page 2,1

 . image plot; memory, 'fish'; x,100

25 . image plot; memory, 'fish'; x+2,100

 . calc x <= x + 1

 . * keep page 1 showing while changing the display on page 2

 . page 1, 2

```

```

. image plot; memory, 'fish'; x,100
. image plot; memory, 'fish'; x+2,100
endloop

```

### System Variables

|   |                 |                                                             |
|---|-----------------|-------------------------------------------------------------|
| 5 | <b>zrpage</b>   | Page currently displayed                                    |
|   | <b>zwpage</b>   | Page on which text and graphics is being written            |
|   | <b>zmaxpage</b> | Maximum number of pages available for screen type in effect |

## palette

Changes the palette.

---

|    |                |                                                   |
|----|----------------|---------------------------------------------------|
| 10 | <b>palette</b> | <i>keyword</i>                                    |
|    | <b>init</b>    | initializes the palette to the default state      |
|    | <b>set</b>     | sets color values for individual palette entries  |
|    | <b>read</b>    | reads palette entries from hardware to variables  |
|    | <b>write</b>   | writes palette entries from variables to hardware |
| 15 | <b>color</b>   | associates a color keyword with a palette entry   |

---

### Description

Changes the set of colors available on palette-based display hardware: EGA, MCGA, VGA, EVGA and compatible graphics adapters. **palette** supports several different functions:

- Changing all or a portion of the current palette
- Reading all or a portion of the current palette setting into variables.
- Changing a color keyword to correspond to a different palette entry.

## 326

A "palette" is the set of colors assigned to the hardware color slots. VGA screens have 16 color slots, and MCGA and EVGA screens have 256 color slots. The "standard palette" is the set of default values for those slots.

Each color is a combination of three color values: red, green, and blue. Together, they are referred to as RGB. Some modes also use an intensity byte to indicate relative brightness for each color. For TenCORE, the standard palette uses the following color assignments:

|    |   |       |   |         |    |        |    |          |
|----|---|-------|---|---------|----|--------|----|----------|
|    | 0 | black | 4 | red     | 8  | black+ | 12 | red+     |
|    | 1 | blue  | 5 | magenta | 9  | blue+  | 13 | magenta+ |
|    | 2 | green | 6 | brown   | 10 | green+ | 14 | brown+   |
| 10 | 3 | cyan  | 7 | white   | 11 | cyan+  | 15 | white+   |

There is no inherent connection between a slot number and the RGB values that it contains. This is relevant when displaying more than one image on the same screen. If the images use different palettes, only the palette of the most recently displayed image will be active. Since the same slots are in use by the other images, their colors might change when a different palette becomes active. Careful planning of a common palette for multiple images on a screen is needed.

The default palette is restored whenever a new main unit is entered. The default palette can be altered by executing a **status save** with the **palette** modifier after changing the palette. The palette is reset to the standard default by executing a **status restore;standard;palette**.  
**palette init [ ;number ]**

20        Initializes the palette to its standard default state. On cards that support multiple defaults, *number* specifies the desired default palette.

**palette set; COLOR, red, green, blue, [ ,intensity ]**

Sets the values of red, green, blue, and optional intensity for the palette slot referred to by *COLOR*. Palette slots can be specified by number or color keyword.

*COLOR* is any hardware color number valid for the hardware in use. *red*, *green*, *blue* and *intensity* range from 0 to 255. For hardware which does not support so wide a range, the values are automatically scaled: 255=full intensity, 128=half, etc. The system variable **zpalincr** reports the minimum significant increment for the color values; **zintincr** gives the minimum significant

5 increment for intensity.

*intensity* is significant only for two screen types: **ega,graphics,low** and **ega,graphics,medium**. On other screen types, **zintincr** is 0 and the intensity value is ignored. This can cause problems when a palette originally generated on either of these two screen types is used on another screen type: it can result in a "dimming" of the palette on the new screen type.

10 This is because the intensity is no longer available, and must be corrected by adjusting the RGB values of the palette.

#### **palette read; buffer, number**

Reads the requested number of palette entries into the variable *buffer*. The structure of the buffer is explained below.

#### 15 **palette write; buffer, number**

Writes the requested number of palette entries from a variable *buffer*. The structure of *buffer* is explained below.

#### **palette color; COLOR, slot**

Associates a TenCORE color keyword with a palette slot. The TenCORE color names by default correspond to the first 16 palette slots. The **color** option allows the author to change

20 which palette slot corresponds to a given color name.

### **Palette Variables**

The **read** and **write** keywords allow palette slot entries to be read to or written from a buffer. The palette buffer contains one or more 6-byte palette entries of the form:

slot (2 bytes)

red (1 byte)

green (1 byte)

blue (1 byte)

5 intensity(1 byte)

The value of *slot* must be set for each palette entry before executing the **read** or **write**.

Any subset of palette entries may be read or written by setting appropriate *slot* values.

### Example

To read the palette information for the default 16 TenCORE color slots:

```

10 define local
 palette(16), 6
 . slot, 2
 . red, 1
 . green, 1
15 . blue, 1
 . intensty, 1
 count , 2
 define end
 *
20 loop count <= 1, 16
 * must remember to initialize slot numbers
 . calc slot(count) <= count - 1
 endloop
 *
25 palette read; palette(1), 16

```



**System Variables**

**zpalincr** Minimum significant increment in color values for current screen type

**zintincr** Minimum significant increment in intensity values for current screen type

**pause**

5 **Pauses execution until event occurs.**

---

**pause** [ time;] [flow= all | KEY/s;] [ pass=all | KEY/s ]

**pause** [ time;] testkeys= all | KEY/s

time delay time in seconds before continuing execution

flow= key list for flow branching

10 pass= key list to continue execution

testkeys= like pass= but key not removed from input buffer

---

**Description**

Stops execution of commands until an accepted event, such as a keypress, occurs. The keypress can pass the pause and continue or perform flow defined key branching. When a keypress is handled by pause it is normally removed from the input buffer and the system input variables such as zinput are updated to reflect the new event.

15

Any break modified flow branch always works: it interrupts any pause to perform its task. Other flow branches are active at a pause only if their keys are specified in the flow= keylist. In either case, if the flow is a do or library branch, control returns to the pause when the subroutine ends.

20

If a time is specified, it sets a clock running that issues the default %timeup key when the time expires. This %timeup key is automatically included in the pass= keylist; unless some other

accepted event occurs first, the **%timeup** allows execution to continue. If a **flow do** or **flow library** branch occurs during a timed **pause**, timing is suspended until the subroutine returns control to the **pause**, then timing resumes.

A **pause** command can extend over several lines if needed to list all options; a blank  
5 command field signifies continuation.

### **pause**

A **pause** command with no tag waits until any event occurs at which time command execution continues. It provides for a temporary program halt: the user presses any key and the program continues. Only **break** modified **flow** branches alter the inevitability of executing the  
10 next command.

### **Example**

```
write Press Any Key to Continue
```

```
pause
```

```
write Good, now let's open the valve and see what happens...
```

15 **pause time**

A **pause** command with only timing forces a delay for the specified time. Only **break** modified **flow** commands can interrupt the time delay. Any other events are ignored and removed from the key input buffer. For a forced delay that doesn't empty the input buffer of events occurring during the delay, use the **delay** command.

20 There is only one default timer key used for both the **pause** and **time** commands:  
**%timeup**. Timing in the **pause** supersedes any default time set by a previous **time** command.

### **Example 1**

```
at 5:10
```

```
write Some text...
```

25 **pause 5**

```

at 7:10
write Some more text...

```

After a 5 second delay, additional text is added to the display.

### Example 2

```

5 flow do; %f5; data; break
...
time 30
...
pause 5

```

- 10        The program is paused for 5 seconds: the previous timing (**time 30**) is cancelled. If [F5] is pressed, the timing is suspended while the **break** modified **flow** branch to unit *data* is done. Upon return, the **pause** waits for the remaining time.

**pause [ time ;] flow= all | KEY/s**

- 15        A **pause** with a **flow=** keylist allows only the specified or **all** flow branches to work. If a **do** or **library** branch occurs, control returns to the **pause** command when the subroutine ends. Optionally, timing can be used to end the **pause** after a given number of seconds. **break** modified **flow** branches always take precedence, whether or not they are listed.

### Example 1

```

pause flow=all

```

- 20        The program is paused until any flow branch occurs. Coding following the **pause** will never be executed.

### Example 2

```

flow jump; %f1; out
flow do; %f2; info
25 flow do; %f3; data
...

```

```
pause 10; flow= %f1, %f2
```

The program is paused for 10 seconds unless [F1] is pressed to **jump** to unit *out*. If [F2] is pressed, timing is suspended while unit *info* is done as a subroutine. Upon return from unit *info*, the **pause** waits for the remaining time. Unit *data* is not accessible from this pause since its

5 branch key is not in the **flow=** keylist.

```
pause [time ;] pass= all | KEY/s
```

A **pause** with a **pass=** keylist allows the specified or **all** keys to pass the **pause** to continue execution of the following commands. Optionally, timing can be used to end the **pause** after a given number of seconds; the resulting **%timeup** key is an automatic entry in the **pass=**

10 keylist. Only **break** modified **flow** branches work here and take precedence over any keys in the **pass=** keylist.

### Example 1

A choice page allows the user to choose a subject for study. Upon choosing one of the options at the **pause**, the program continues to branch (with arguments) to the appropriate

15 section of the lesson. The **break** modified branch to unit *index* is the only **flow** branch which can occur at the **pause**.

```
flow jump; %f1; index; break
```

```
flow jump; %f2; notes
```

```
...
```

20 write Choose an option:

```
 a. anthracite coal
```

```
 b. bituminous coal
```

```
 c. peat
```

```
pause pass= a, b, c $$ only accept a,b,c
```

25 if zinput = "a"

333

```
. jump unita(3,5,1)
elseif zinput = "b" $$ et cetera
...
```

### Example 2

```
5 pause 10,pass=a,b,c,d,e,f,g,h,i,j,k,l,m,
 n,o,p,q,r,s,t,u,v,w,x,y,z,
 0,1,2,3,4,5,6,7,8,9
```

The tag of a **pause** command can extend over several lines. This **pause** waits for 10 seconds or until one of the listed keys is pressed.

### 10 Example 3

```
write Lots and lots of text
 over many,
 many lines.
nextkey clear
15 pause pass=a,b,c
```

If there is time consuming coding such as a large display, keys might be stacked up in the input buffer before a **pause** command is executed. The **pause** processes these waiting keys until it comes to one that it passes. This can be desirable sometimes since it allows the user to type ahead. If type ahead is not desired, use a **nextkey clear** statement before the **pause**. It empties  
20 the key buffer of all pending keys.

**pause [ time ; ] flow= all | KEY/s ; pass= all | KEY/s**

Both the **flow=** and **pass=** keylists can occur in the same statement with **pass=** keys taking precedence over **flow=** keys. Optionally, timing can be used to end the **pause** after a given number of seconds. **break** modified **flow** branch keys work in all instances.

The pseudo-key value **%other** can be placed in either keylist to include all keys that are not individually assigned. If put into the **flow=** keylist (or by use of the **all** keyword), then any **flow** statement with the **%other** pseudo-key is activated.

#### Example 1

```
5 pause flow=all; pass=%other
```

All **flow** keys are active. All other keys pass the **pause** to continue execution of the unit.

#### Example 2

```
flow jump; %timeup; timeout
...
10 time 10
pause flow=all; pass=a,b,c
```

Timing here has been set before and not overridden by the **pause** statement. When the system generates a **%timeup** key, a **flow** branch to unit *timeout* occurs.

#### Example 3

```
15 flow jump; %f1; =exit
flow jump; %f2; index
flow do; %f5; data
flow jump; %timeup; timeout
...
20 pause 10; flow=all; pass=a,b,c,%pointer
```

Pressing [A],[B] or [C] or any pointer click passes the pause to the following command. Any of the specified **flow** keys (but **%timeup**) perform their defined **flow** functions. If no other accepted event occurs for 10 seconds, execution continues with the command following the **pause**. Control does not pass to unit *timeout* since the **pause** command's timing automatically includes **%timeup** in the **pass=** keylist, which takes precedence over **flow** assignments.

**Example 4**

```

flow jump; %f1; =exit
flow jump; %f2; index
flow do; %pgup,%pgdn; nextunit
5 flow do; %other; badKeys
...
pause flow=all; pass=a,b,c,%space,%f2

```

Pressing [A],[B],[C] [] or [F2] passes the **pause** to the following command. The %f2 **flow** branch is not taken because the key is in the **pass=** keylist which takes precedence. The %f1 **flow** branch and any other **flow** branches work because of the **flow=all**. Any key not included in the **pass=** keylist and not defined in other **flow** statements performs the **flow do** to unit *badKeys* which handles unanticipated keys.

**pause [ time ;] testkeys= all | KEY/s**

The **testkeys=** form is similar to **pass=** except that passed keys are not removed from the input buffer. It is used to test pending input since the system input variables such as **zinput** are updated. The passed key remains in the input buffer until a following input processing point (**pause**, **arrow**, **nextkey**, end-of-unit). **testkeys=** is the **pause** form of the **nextkey test** command.

**testkeys=** cannot occur with any other of the keylist forms.

20      **Example**

```

pause testkeys=0,1,2,3,4,5,6,7,8,9
long 1,judge
arrow 10:10
answer 3
25 . write Great!
wrong 2

```

```

. write No, that's Mars.
wrong 1
. write No, that's Mercury.
...
5 endarrow

```

Only the number keys cause termination of the **pause**. Since the passed key is not removed from the input buffer by the **testkeys=** form, it remains as input for the following **arrow**. After displaying on the screen at the **arrow**, the key immediately causes judging to occur due to the **long 1, judge**.

## 10      **Obsolete Form**

The ambiguous **keys=** form of the previous version of the system is now replaced with the explicit **pass=** and **flow=** keylist forms. It was not possible by looking only at the **keys=** keylist to predict whether a listed key would perform a **flow** branch or pass the **pause** to the next command. While the **keys=** form still works for reasons of upward compatibility, users are

15    advised to switch to the new unambiguous forms.

## **System Variables**

The input-related system variables are updated whenever **pause** processes a key.

|    |                |                                                    |
|----|----------------|----------------------------------------------------|
|    | <b>zinput</b>  | Most recent keypress, pointer input, or pseudo-key |
|    | <b>zinputa</b> | Area ID causing current zinput value               |
| 20 | <b>zinputf</b> | Bitmap of keyboard conditions at time of event     |
|    | <b>zinputx</b> | Pointer x-coordinate at time of event              |
|    | <b>zinputy</b> | Pointer y-coordinate at time of event              |
|    | <b>zkeyset</b> | Keyboard scan code                                 |
|    | <b>zpcolor</b> | Color of screen under pointer at time of event     |



**perm****Manages permutation lists.**

---

**perm** keyword...**create** generates permutation list in memory5 **next** gets next number from permutation list**remove** removes specific number from permutation list**replace** puts specific number back into permutation list**copy** makes copy of permutation list**delete** deletes permutation list from memory10 **reset** deletes all permutation lists from memory**read** reads permutation list into variables**write** writes list in variables to permutation list

---

**Description**

15 The permutation managing options available through the **perm** command allow for the random selection, removal and replacement of a number from a list of numbers. Multiple permutation lists can be accessed simultaneously. Copies of a list can be saved and restored at any time in memory or even to the disk between sessions to allow for any possible strategy in using permutations.

20 Permutation lists can be created in the one system **default** buffer or in any number of named buffers. If possible, the use of the **default** buffer simplifies using permutations since the name argument can be eliminated. The **default** buffer for the **perm** command is shared by all units.

Permutation list buffers are kept as memory blocks in the memory pool. The memory pool is used by the commands: **memory**, **image**, **window**, **status**, **area**, **flow**, **font** and **perm**.

Memory blocks are tagged as belonging to a specific command type at creation and cannot be accessed by other commands using the memory pool; different commands can use the same name for a memory block without conflict.

**perm create; length [; 'NAME' | default ]**

Creates a permutation list of non-repeating, randomly-ordered integers from 1 to the specified length (maximum 32,767). The list is stored as the **default** or a user named buffer in the memory pool. Creating a new **default** list automatically supersedes any previous use of the **default** buffer. Creating a named list produces an error if the named list already exists; use the **delete** option first if you wish to use the same name again.

#### Example 1

Creates a default permutation list of integers from 1 to 10.

**perm create; 10**

#### 15 Example 2

Creates a permutation of integers from 1 to 25; the list is saved in the memory block named *quiz 1*.

**perm create; 25; 'quiz1'**

**perm next; variable [; 'NAME' | default ]**

20 Randomly selects a permutation number and stores it in a variable. The number selected is removed from the permutation list. If the permutation list is empty or an error occurs, 0 is returned.

**Example 1**

Gets the next number from the default permutation list and puts it into the variable *question*; the number is removed from the list.

```
perm next; question
```

5 **Example 2**

Like Example 1 but the number comes from the named list *quiz1*

```
perm next; question; 'quiz1'
```

**Example 3**

10 A permutation of 5 items is created in the default buffer. Within a loop, the five questions in units *Q1* through *Q5* are presented in random order. When the list is exhausted, the 0 value in variable *question* is used to exit the loop structure.

```
perm create; 5 $$ create default permutation list
jump zreturn; ; error
loop
15 . perm next; question $$ get next permutation number
 . do question;;;Q1;Q2;Q3;Q4;Q5 $$ call question
outloop question = 0 $$ exit loop if done
endloop

perm remove; itemNumber [; 'NAME' | default]
```

20 Removes the specified item from a permutation list. The integer is no longer available for selection by a **perm next** statement.

**Example**

Removes the value in *problem* from the default permutation list.

```
perm remove; problem
```

**perm replace; itemNumber [; 'NAME' | default ]**

Puts the specified item back into a permutation list. The integer is available again for selection by a **perm next** statement.

### Example

5 Puts the value in *problem* back into the default permutation list

```
perm replace; problem
```

```
perm copy; ['FROM' | default] ; ['TO' | default]
```

Makes a copy of a permutation list. If the copied-to list already exists, it is overwritten.

The **default** list can occur only once in the statement.

10 **Example 1**

Copies permutation *list first* into the named list *second*.

```
perm copy; 'first'; 'second'
```

### Example 2

Copies the default permutation list to the list named in the variable *newList*

15 **perm copy; default; newList**

```
perm delete [; 'NAME' | default]
```

Deletes a permutation list from memory.

```
perm reset
```

Deletes all permutation lists from memory.

20 **perm read; permBuffer [,length ] [; 'NAME' | default ]**

Reads a permutation list into the specified buffer for a given length in bytes. If length is not specified, the defined length of the buffer is used.

The **read** and **write** forms of the **perm** command are for use in saving and restoring a permutation list on the disk between learner sessions.

The structure of the buffer is as follows:

| Item                      | Bytes |
|---------------------------|-------|
| Version of <b>perm</b>    | 2     |
| Length of list            | 2     |
| Number of remaining items | 2     |
| Item bitmap               | N     |

The item bitmap is formatted such that each bit corresponds to a number in the permutation list: if the bit is "1", the item is still available; 0 indicates it has been removed. For example, if bit 3 is set to 1, the number 3 has not yet been removed from the permutation list. The length of the item bitmap is determined by the length of the list. Since each byte can hold the status of 8 items, N is the length of the list divided by 8, rounded up. It can be computed as  $\text{int}((\text{length}+7)/8)$  or  $((\text{length}+7) \div 8)$ .

**perm write; permBuffer [,length] [; 'NAME' | default ]**

Writes a given length of bytes from a buffer into a permutation list. If the length is not specified, the defined length of the buffer is used.

#### System Variable

##### zreturn

- 2 Redundant operation: replace used with number already in list or remove used with number already removed
- 15 - 1 Operation Successful
- 3 Out of range: attempt to create list larger than 32,767 or attempt to remove or replace number larger than list size
- 6 Duplicate name using create
- 10 Name not found
- 20 17 Attempt to write invalid permutation list data
- 18 Insufficient space in memory pool

## polygon

**Draws a polygon**

---

```
polygon[LOCATION]; [LOCATION]; [LOCATION] ... [;fill]
```

---

### Description

5        Draws a polygon in the foreground color using the specified LOCATION as vertices. The optional modifier fill specifies that the polygon be filled. Only convex polygons can be filled; concave ones must be split into multiple convex ones (see below). A minimum of three points must be specified. A maximum of 50 points may be specified. If the last point does not match the first, they are connected.

10       A polygon is affected by scale, rotate and width. Filled polygons function only when any horizontal line intersects exactly two points on the polygon.

Splitting a concave polygon into multiple convex polygons will produce the desired shape

```
polygon 0,100; 200,0; 200,100 $$ draws a triangle
```

```
polygon 10:10; 10:20; 20:20; 20:10 $$ draws a rectangle
```

15       polygon 0,100; 200,0; 200,100; fill        \$\$ draws filled polygon

## press

**Generates an input value.**

---

```
press KEY | expression [,first]
```

```
press KEY | expression [,inputF [,inputX,inputY [,inputA]]] [, first]
```

---

20       **Description**

The **press** command puts a specified key into the input buffer as if pressed on the keyboard. At the next input-processing point (**pause**, **arrow**, **nextkey**, or end-of-unit), the key is

processed and performs whatever function a similar real keypress does including the update of the system variable **zinput**

The optional modifier **first** causes the key to be inserted before any other keys waiting in the input buffer: it will be processed first.

5        Optionally, the values for the system variables **zinputf**, **zinputx**, **zinputy**, and **zinputa** can be specified so as to be set along with **zinput** when the key is processed. If a value is not specified, the corresponding system variable is set to zero.

The *KEY* values for **press** are limited: embedding and the simple a,b,c form are not available. However, the key can be an expression such as a constant, variable or calculation.

## 10        Examples

### Example 1

Puts %space into the input buffer as if it had been pressed on the keyboard.

```
press %space
```

### Example 2

15        Places %F1 in the input buffer before any other keys waiting to be processed; it will be processed first.

```
press %F1; first
```

### Example 3

20        Simulates a pointer click by placing the key value %pointer along with location and area id information into the input buffer. At the next input-processing point, **zinput**=%pointer, **zinputx**=320, **zinputy**=240, and **zinputa**=5. Since no value is specified for **zinputf**, it is set to 0.

```
press %pointer, , 320, 240, 5
```

### Example 4

25        After an unsuccessful try at the question, the learner is given the first few letters of the correct answer typed in as input to the arrow.

**write**     Who is buried in Grant's tomb?

**arrow**

**answer**    «U,Ulysses,S» Grant

**no**

5     **write**     Press any key for a hint.

**pause**

**press**     %enter                    \$\$ erases the mistake

**press**     %"G"

**press**     %"r"

10   **endarrow**

### System Variable

**zreturn**

     -1        Operation successful

     0        Key buffer overflow

## 15   **print**

Sends output to the printer, or changes print parameters.

---

**print**        variable, length

**print**        initial; prn | lpt1 | lpt2 | lpt3 | com1 | com2

**print**        initial ; file, 'FILENAME' [ ,length ]

20   **print**        end

     buffer   variable buffer to output to printer

     length   number of bytes to send to the printer

     initial   changes the printer device

     end       ends network spooling and resets printer to lpt1

---



## Description

Sends the specified number of bytes to the standard printer device **lpt1**, or to another device or file specified by **print initial**.

Legal devices for **print** are:

5     **prn, lpt1, lpt2, lpt3, com1, and com2.**

The **initial** keyword changes the device used for printing. With the **file** form, a file name is specified. The ASCII filename string may include a drive and path, and must be terminated with a null byte. If the length is not specified, the defined length of the variable is used.

If the specified file already exists, it is initialized to 0 length in preparation for printing.

10     The **end** keyword clears any printer connection established with **print initial**. On a network system, it also terminates printer output spooling and initiates printing.

Unless otherwise specified by **print initial**, output is sent to **lpt1**.

**print** only sends the specified characters to the printer. Printer control characters are not added to the output. Refer to the manufacturer's manual for printer control codes.

15     Most printers require an ASCII carriage return code (h0d) or a carriage return/line feed sequence (h0d0a) at the end of each line to position the print head and paper for the next line.

Technical Note: When no printer connection is in effect, printer output is sent to the BIOS INT 17H printer driver, device 0 which is normally **lpt1** unless it has been redirected. When a printer connection is active, printer output is sent to the device via the standard DOS

20     "write" call.

## Examples

### Example 1

Prints the title line for a report. The user's name is stored in *username*. Note that a carriage return/line feed sequence is included.

```

define local

username, 20 $$ name of user

text, 100 $$ text to print

texten, 2 $$ length of text to print

5 CRLF = h0d0a $$ carriage return and line feed

define end

*

packz text;textlen;Test results for «showa,username»

 « showa,CRLF »

10 *

print text, textlen $$ print the line

```

### Example 2

Redirects future printing to lpt2.

```
print initial; lpt2 $$ initialize lpt2
```

### 15 Example 3

Redirects future printing to file *C:\TENPRINT.PRN*

```

define local

filename, 40

define end

20 packz filename;;c:\tenprint.prn $$ put filename in variable

print initial; file, filename $$ redirect output to file

```

### System Variable

#### zreturn

- 1            Operation Successful

25            0            Disk error (see **zdoserr** and **zedoserr**)

**put**

Substitutes one string of characters for another.

---

**put**    *fromTEXT*; to *TEXT* [ ,buffer [ ,length ] ]

*fromTEXT*    text string to find and replace

5            *toTEXT*       replacement text sting (can be null)

*buffer*       user variable buffer on which to perform replacement

*length*       maximum length for buffer

---

**Description**

Replaces every occurrence of *fromTEXT* with *toTEXT* in the student response buffer at an  
 10    arrow or optionally in any specified buffer. The *TEXT* occurs without quotes and can contain  
 embedded show commands.

**Examples****Example 1**

Shows how put can be used to change an abbreviation to its full word equivalence in  
 15    answer judging.

**write**       What is the biggest US city?

**arrow**       10:10

**put**          NY, New York

**answer**      New York

20    .           write      Great!

**endarrow**

**Example 2**

Replaces all occurances of "dog" with "elephant" in the buffer *mystring*.

**put**          dog,elephant,mystring

**Example 3**

Embedded text can be used for both the *from* and *to* strings.

```
put «a,oldchars,oldlen»,«a,newchars,newlen»,textvar,length
```

**Example 4**

- 5 This produces a 24-hour type clock display. If the hours or minutes are less than 10 the tens digit would contain a space from the **showt's** of the **pack**. The **put** replaces any spaces in *var* with the digit 0.

```
pack var, length,«showt, hrs, 2»:«showt, mins, 2»
```

```
put ,0, var, length $$ from string is just a space
```

```
10 * replace spaces with 0
```

```
showa var, length
```

**System Variables**

**zreturn**

- |      |                                                      |
|------|------------------------------------------------------|
| -1   | Operation successful, all possible replacements made |
| 15 0 | Insufficient room for replacement                    |

**Miscellaneous**

**zlength**      Length of the text string after replacement

**znumber**      Number of replacements made

**zcount**      Length of response buffer, if used

20 **receive**

**Receives argument values passed to a subroutine**

---

receive argument/16s

---

### Description

Receives arguments passed to a subroutine unit and places their values in the specified variables. Null arguments are specified by blank entries (,) in the argument list.

Arguments can be passed by **do**, **library**, **jump**, and **jumpop** commands. The following

5 applies to **receive**:

- Any element in the argument list may be null. A null element in the argument list causes the corresponding passed value to be ignored.
- A literal used as a receive argument causes a condense error.
- Only numeric integer and real variables are valid in the argument list. A text  
10 variable of eight characters or less is considered a numeric in this context.
- Any number of **receive** commands may be executed, and any **receive** may be executed an arbitrary number of times. Each time a **receive** is executed, the originally passed arguments are used.
- Intervening calls to other units (which can receive or return their own arguments)  
15 have no effect on the values received in the current unit (passed values are local to the individual units).
- If a null argument is sent, the corresponding element in the **receive** list is not changed.
- Normally, the number of arguments received must match the number passed,  
20 otherwise an execution error occurs. This can be overridden by using **nocheck receive**.

### Example

Unit *one* passes arguments to subroutine *circles*.

350

one

.

.

.

5 do circles(160, 100, 5)

.

.

.

circles

```

10 define local
 x, 2 $$ center of circles
 y, 2
 n, 2 $$ number of circles
 r, 2 $$ radius of circle
15 define end
 *
 receive x, y, n
 at x,y
 loop r <= 10, n * 10, 10
20 . circle r
 endloop

```

### System Variables

**zargsin**      Number of arguments (including nulls) sent to subroutine

**zargsout**     Number of return arguments expected

25 **zargs**      Number of non-null arguments actually received

## reloop

Returns to the beginning of a LOOP structure.

---

**reloop** [ *CONDITION* ]

---

### Description

- 5           Used to restart the loop structure. If the tag is blank or the condition is true, **reloop** returns to the beginning of the loop structure as if **endloop** had been executed. If the condition is false, execution continues with the next command. **reloop** always appears at the same indentation level as the **loop** command to which it returns, regardless of any other indented structures surrounding the **reloop**.
- 10           For more information on loop structures, see the loop command.

### Example

An *ITERATIVE* loop which skips the case when the *counter* is 13.

```
define local
index, 2 $$ loop counter
15 define end
*
loop index <= 1,20
reloop index = 13
. at index:5
20 . write This is line «show, index».
endloop
```

**return**

Ends subroutine execution optionally returning arguments.

---

```
return [argument/16s]
```

---

**Description**

- 5 Exits immediately from the current unit if it was called by **do** or **library**. If the unit was not called by a **do** or **library**, an execution error occurs.

The blank-tag form causes an exit from the unit with no arguments passed back to the calling unit.

- 10 If a list of return arguments is specified, the values are returned to the calling unit. A null entry in the return list causes the corresponding value in the receive argument list to remain unchanged.

See the **receive** and **nocheck** command descriptions for more information on argument passing.

**Example**

- 15 Unit *test* calls subroutine *square*, passing it one argument; subroutine *square* receives that argument, uses it in a calculation, then returns the resulting value to the variable *numsquar* back in unit *test*

**test**

- 20 .  
.  
**do**        **square (12 ; numsquar)**  
**show**    **numsquar**  
.



**square**

```
define local
```

```
number
```

```
5 number2
```

```
define end
```

```
*
```

```
receive number
```

```
calc number2 \leftarrow number * number
```

```
10 return number2
```

**System Variables****Miscellaneous**

**zargsin**      Number of arguments, including nulls, sent to subroutine

**zargsout**     Number of arguments the calling **do** or **library** expects returned

15    **zargs**      Number of non-null arguments actually received by **receive**

**rotate**

Rotates subsequent graphic objects.

---

```
rotate [degrees [;LOCATION]]
```

---

**Description**

20      Causes all subsequently plotted graphic objects to be rotated by the specified number of *degrees*. Rotation occurs counter-clockwise about the plotting origin, as specified by the **origin** command, unless an optional location is specified. Specifying a rotational origin affects only subsequently rotated objects.

The system default is **rotate 0** (no rotation), set at each main unit and by **initial** and **status restore; default**. The blank-tag form also sets the standard default of no rotation. The default can be changed using **rotate** followed by **status save; default**.

The effect of the graphic transformation commands, including **rotate**, can be temporarily  
 5 suspended with **enable absolute** and restored with **disable absolute**.

The display control commands are applied in the following order:

**scale**

**rotate**

aspect ratio correction

10 **origin**

window relative coordinates

window clipping

The following objects are not subject to rotation:

text

15 images

windows

boxes and erases specified using characters and lines (e.g., **box 10,3**)

To rotate text, see the **text rotate** command.

### Example

20 A box is continuously rotated at the center of the screen.

```
define local
```

```
degree , 2
```

```
define end
```

```
*
```

355

```
origin zdisp x /2, zdisp y /2 $$ middle of the screen
```

```
mode xor
```

```
loop
```

```
. rotate degree
```

```
5 box -50,-50; 50,50;1 $$ plot box
```

```
 delay 01
```

```
. box -50,-50; 50,50;1 $$ erase box
```

```
. calc degree \Leftarrow degree +1
```

```
endloop
```

## 10 System Variables

**zrotate**      Number of degrees of rotation.

**zrotatex**     The X coordinate of the rotation origin.

**zrotatey**     The Y coordinate of the rotation origin.

## scale

### 15 Scales graphic objects.

---

```
scale [factor | Xfactor, Yfactor [LOCATION]]
```

---

#### Description

Causes all subsequently plotted graphic objects to be scaled by the given factor or separate x (horizontal) and y (vertical) factors may be specified. For example, **scale .5** would make all graphics objects 1/2 size, while **scale 2,3** would double graphics in the x direction, and triple them in the y direction. Scaling occurs relative to the plotting origin, as specified by the **origin** command, unless an optional scaling origin location is specified.

Specifying a scaling origin affects only subsequently scaled objects.

The standard default is **scale 1** (no scaling), set at each main unit and by **initial** and **status restore; default**. The blank-tag form also sets the standard default of no scaling. This default can be changed with **status save; default**.

The effect of the graphic transform commands, including **scale**, can be temporarily  
 5 suspended with **enable absolute** and restored with the **disable absolute**.

The display graphic transform are applied in the following order:

**scale**

**rotate**

aspect ratio correction

10 **origin**

window relative coordinates

window clipping

The following objects are not subject to scaling:

text

15 images

windows

boxes and erases specified using characters and lines (e.g., **box 10,3**)

### **Example**

Produces a series of concentric boxes.

```

20 define local
 factor, 2
 define end
 *
 origin zdisp x /2, zdisp y /2
25 *
```

```

loop factor ← 1,10
. scale factor
. box -10,-10;10,10;1
endloop

```

## 5 System Variables

**zscalex**        The horizontal scaling factor ( 8-byte real)

**zscaley**        The vertical scaling factor (8-byte real)

**zscalex**        x-coordinate of the scaling origin

**zscaley**        y-coordinate of the scaling origin

## 10 screen

Sets or tests screen resolution type.

---

|    |                   |                                                                                                                |
|----|-------------------|----------------------------------------------------------------------------------------------------------------|
|    | <b>screen</b>     | [ <b>test</b> , ] <i>type</i> [ , <i>mode</i> ] [ , <i>resolution</i> ] [ , <i>chrome</i> ]                    |
|    | <b>screen</b>     | [ <b>test</b> , ] <b>variable</b> , <i>type</i> , <i>mode</i> , <i>resolution</i> , <i>chrome</i>              |
|    | <b>screen</b>     | <b>native</b>   <b>edit</b>                                                                                    |
| 15 |                   | <i>type</i> keywords and values:                                                                               |
|    |                   | <b>cga</b> 0                                                                                                   |
|    |                   | <b>ega</b> 3                                                                                                   |
|    |                   | <b>vga</b> 10                                                                                                  |
|    |                   | <b>mcga</b> 11                                                                                                 |
| 20 |                   | <b>evga</b> 1                                                                                                  |
|    | <i>mode</i>       | keywords and values                                                                                            |
|    |                   | <b>graphics</b> 0                                                                                              |
|    |                   | <b>text</b> 1                                                                                                  |
|    | <i>resolution</i> | keywords and values                                                                                            |
| 25 |                   | <b>low</b> 0                                                                                                   |
|    |                   | <b>medium</b> 1                                                                                                |
|    |                   | <b>high</b> 2                                                                                                  |
|    |                   | <b>alt1</b> 3                                                                                                  |
|    |                   | <b>alt2</b> 4                                                                                                  |
| 30 |                   | <b>alt3</b> 5                                                                                                  |
|    | <i>chrome</i>     | keywords and values:                                                                                           |
|    |                   | <b>color</b> 0                                                                                                 |
|    |                   | <b>mono</b> 1                                                                                                  |
| 35 | <b>test:</b>      | Only check if specified settings work and return result in <b>zreturn</b> , don't actually change settings.    |
|    | <b>ative:</b>     | Set screen to highest possible settings (up to <b>vga</b> ) for given display driver.                          |
|    | <b>edit:</b>      | Put settings to editor's settings.                                                                             |
|    | <b>variable:</b>  | Use numeric values instead of keywords for <i>type</i> , <i>mode</i> , <i>resolution</i> , and <i>chrome</i> . |

---

### Description

Sets the screen hardware to the specified type, mode, resolution, and chrome. The choice of a screen setting is limited by the display driver, display controller and the monitor being used.

In producing courseware that is to run on a wide variety of IBM PCs directly using the DOS software platform, one needs to select a screen setting that is compatible with the lowest common display hardware.

Normally, the **screen** command occurs once at the beginning of a lesson as in the **+initial** control block.

When a **screen** command changes screen settings, the screen is erased, the display page is reset to 1, and all plotting parameters are reset to **standard** as if the following statements are executed:

```
status restore; standard
status save; default
```

### Shorthand Notation

The most popular screen settings can be selected without inputting all arguments.

Graphics and color are the default settings. The resolution usually defaults to the standard value for the display controller type.

| Shorthand             | Fully Specified Form       |
|-----------------------|----------------------------|
| screen cga            | cga,graphics,medium,color  |
| screen, cga,high,mono | cga,graphics,high,mono     |
| screen, ega           | ega,graphics,high,color    |
| screen ega,medium     | ega,graphics,medium,color  |
| screen ega,low        | ega,graphics,low,color     |
| screen vga            | vga,graphics,medium,color  |
| screen mcga           | mcga,graphics,medium,color |
| screen mcga,high,mono | mcga,graphics,high,mono    |
| screen evga           | evga,graphics,high,color   |
| screen evga,medium    | evga,graphics,medium,color |

## Examples

### Example 1

Selects the 640 x 480 x 16 color (vga,medium.graphics,color) screen. if the screen is not possible, a message is given before a branch exits the user back to the calling system.

```

5 screen vga
 if not(zreturn) $$ see if can't set screen
 . write Warning.
 VGA Screen Type not available.
 . pause
10 . jump =exit $$ exit to router or DOS
 endif

```

### Example 2

Tests whether the 1280 x 1024 x 256 color screen is available. If so, the high resolution version of a chemistry lesson is used. If not, the lower resolution version of the lesson is used.

```

15 screen test, evga, alt2
 if zreturn $$ see if true(-1)
 . jump chemHigh,start $$ use high resolution version
 else
 . jump chemLow,start $$ use lower resolution version
20 endif

```

## Screen Types and Display Drivers

| Screen       | Pixels  | Palette | Colors  | Chars | CharSize | DisplayDrivers |
|--------------|---------|---------|---------|-------|----------|----------------|
| IBM Standard |         |         |         |       |          |                |
| cga, medium  | 320x200 | 4       | 16      | 20:40 | 8x10     | CEVS           |
| cga, high    | 640x200 | 2       | 16      | 20:80 | 8x10     | CEVS           |
| ega, low     | 320x200 | 16      | 16*     | 20:40 | 8x10     | EVS            |
| ega, medium  | 640x200 | 16      | 16*     | 20:80 | 8x10     | EVS            |
| ega, high    | 640x350 | 16      | 64*     | 25:80 | 8x14     | EVS            |
| mcga, medium | 320x200 | 256     | 262,144 | 20:40 | 8x10     | VS             |
| mcga, high   | 640x480 | 2       | 262,144 | 30:80 | 8x16     | VS             |

## 360

|                           |     |         |        |       |    |
|---------------------------|-----|---------|--------|-------|----|
| mcga, high, color 360x480 | 256 | 262,144 | 30:45  | 8x16  | VS |
| vga, medium 640x480       | 16  | 262,144 | 30:80  | 8x16  | VS |
| Enhanced VGA***           |     |         |        |       |    |
| vga, high 800x600         | 16  | 262,144 | 33:88  | 9x18  | S  |
| vga, alt1 1024x768        | 16  | 262,144 | 38:102 | 10x20 | S  |
| vga, alt2 1280x1024       | 16  | 262,144 | 42:106 | 12x24 | S  |
| evga, low 640x400         | 256 | 262,144 | 25:80  | 8x16  | S  |
| evga, medium 640x480      | 256 | 262,144 | 30:80  | 8x16  | S  |
| evga, high 800x600        | 256 | 262,144 | 33:88  | 9x18  | S  |
| evga, alt1 1024x768       | 256 | 262,144 | 38:102 | 10x20 | S  |
| evga, alt2 1280x1024      | 256 | 262,144 | 42:106 | 12x24 | S  |

\* when using *VGA.DIS* or *EVGA.DIS* the number of possible colors is 262,144

\*\* display drivers supporting each screen are denoted by the following letters:

C CGA.DIS

E EGA.DIS

5 V VGA.DIS

S EVGA.DIS

\*\*\*most Super VGA cards supported, either directly or through VESA standard

### System Variables

#### zreturn

10 The **screen** command sets **zreturn** to the following values.

-2 ok, screen not changed; the requested screen already in effect

-1 ok, screen changed (not changed for **screen test** form)

0 Invalid screen for display driver file

1 Display adapter does not support requested screen

15 When a **screen** command executes successfully, the following set of system variables are

**reset** They are not altered for the **screen test** form.



## 361

|    |                 |                                 |
|----|-----------------|---------------------------------|
|    | <b>zscreent</b> | Screen type selected            |
|    | 0               | cga                             |
|    | 2               | hercules                        |
|    | 3               | ega                             |
| 5  | 9               | att                             |
|    | 10              | vga                             |
|    | 11              | mcga                            |
|    | 14              | evga                            |
|    | <b>zscreenm</b> | Screen addressing mode          |
| 10 | 0               | graphics                        |
|    | 1               | text                            |
|    | <b>zscreenr</b> | Screen resolution               |
|    | 0               | low                             |
|    | 1               | medium                          |
| 15 | 2               | high                            |
|    | 3               | alti                            |
|    | 4               | alt2                            |
|    | S               | alt3                            |
|    | <b>zscreenc</b> | Screen chrome                   |
| 20 | 0               | color                           |
|    | 1               | mono                            |
|    | <b>zscreen</b>  | Screen type as reported by BIOS |

| Value | Meaning                 | Screen Command        |
|-------|-------------------------|-----------------------|
| 0     | 40 x 25; text; mono     | cga,text,medium, mono |
| 1     | 40 x 25; text; 16 color | cga,text,medium,color |

|                                        |                                |                           |
|----------------------------------------|--------------------------------|---------------------------|
| 2                                      | 80 x 25; text; mono            | cga,text,high,mono        |
| 3                                      | 80 x 25; text; 16 color        | cga,text,high,color       |
| 4                                      | 320 x 200; graphics; 4 color   | cga,graphics,medium,color |
| 5                                      | 320 x 200; graphics; mono      | cga,graphics,medium,mono  |
| 6                                      | 640 x 200; graphics; mono      | cga,graphics,high         |
| 7                                      | 80 x 25; text (on MDA)         | cga,text                  |
| 13                                     | 320 x 200; graphics; 16 color  | ega,graphics,low          |
| 14                                     | 640 x 200; graphics; 16 color  | ega,graphics,medium       |
| 16                                     | 640 x 350; graphics; 16 color  | ega,graphics,high         |
| 17                                     | 640 x 480; graphics; 2 color   | mcga,graphics,high        |
| 18                                     | 640 x 480; graphics; 16 color  | vga,graphics,medium       |
| 19                                     | 320 x 200; graphics; 256 color | mcga,graphics,medium      |
| 106*                                   | 800 x 600; graphics; 16 color  | vga,graphics,high         |
| 107*                                   | 800 x 600; graphics; 256 color | evga,graphics,high        |
| 108*                                   | 1024x 768; graphics; 16 color  | vga,graphics,alt1         |
| 109*                                   | 1024x 768; graphics; 256 color | evga,graphics,alt1        |
| 113*                                   | 1280x1024; graphics; 16 color  | vga,graphics,alt2         |
| 114*                                   | 1280x1024; graphics; 256 color | evga,graphics,alt2        |
| *VESA-compatible display adapters only |                                |                           |

**zscreenh** Display driver file (*.DIS* file) in use (adjusted for the display hardware actually detected: e.g., if **EVGA.DIS** detected VGA hardware, **zscreenh** will be 10)

|    |          |
|----|----------|
| 0  | cga      |
| 2  | Hercules |
| 3  | ega      |
| 9  | att      |
| 10 | vga      |
| 11 | mcga     |
| 14 | evga     |

10 **zinaxcol** Maximum number of colors available for current screen type

**zpalincr** Minimum change in RGB value required to have an effect on displayed color (see **zintincr**)

**zintincr** Minimum change in intensity value required to have an effect on displayed color (see **zpalincr**)

**zmaxpage**      Maximum number of pages available

## **seed**

**Obtains or sets the random number seed.**

---

**seed**    variable4 [; set ]

---

### 5      **Description**

Used in the calculation of random numbers. Each time a new random number is generated, the system sets the seed to a new value. The random number seed is used by the **perm** command and the **randi** and **randf** functions

The current seed is obtained by using a 4-byte integer variable as the single argument to  
10 the **seed** command. The seed is set by specifying a 4-byte integer value (0 to 4,294,967,295) and using the **set** keyword. The system initializes the seed to the arbitrary value of **zclock** at start-up.

The **seed** command is normally used for repeatable random number sequences: the same random number sequence can be generated again by saving the initial seed and restoring it later. For example, if two permutation lists are generated starting from the same seed value, the lists  
15 will be identical.

### **Example**

A scatter-graph of 100 random dots is first placed on the screen then erased after a pause. The seed is saved before the first generation of random dots then restored before the second "erase" generation of the same identical dots.

```
20 define local
 save,4,integer
 index,2
 define end
```

```

...
seed save $$ save the seed
loop index \leftarrow 1, 100
. dot index, randi(100)
5 endloop
pause
mode erase
seed save; set $$ restore the saved seed
loop index \leftarrow 1, 100

```

## 10 set

Assigns a series of values to consecutive variables.

---

```

set variable \leftarrow value 1, value2, ...

 variable starting variable for assignments

```

---

### Description

- 15 Assigns a list of values to consecutive memory locations, starting at the location of the specified variable. The first value to the right of the assignment arrow is assigned to *variable*. After that, consecutive memory locations of the same size and type as *variable* are assigned the remaining values in the tag, regardless of how subsequent variables may be defined. The variable given in **set** is often the first element of an array, but it may be any variable that is valid with **calc**.
- 20 The tags of **set** may be continued in the tag field of subsequent lines.

A null "value" can be used to skip an assignment.

### Example

Assigns a series of values to an array. Note that *array(3)* is not assigned and retains its original value.

```
define local
```

```
array(4), 2
```

```
define end
```

```
set array(1) ⇐ 15, 96, , score*100
```

```
5 or
```

```
set array(1) ⇐ 15, $$ continued across multiple lines
```

```
96, ,
```

```
score*100
```

The set commands above are equivalent to the following **calc** commands:

```
10 calc array(1) ⇐ 15
```

```
calc array(2) ⇐ 96
```

```
calc array(4) ⇐ score*100
```

## setbit

Sets a bit in a variable.

---

```
15 setbit variable,bit,value
```

```
variable variable containing the bit to set
```

```
bit bit number to set
```

```
value value for bit (0 or 1)
```

---

## Description

20 Sets a single bit in a variable. With this command, a single variable can be used for a number of one-bit flags, making more efficient use of variable space.

Bit 1 is the left-most (highest-order) bit. A bit number can be specified that crosses variable boundaries. If the value to set the bit to is other than zero or one, the right-most bit of the value is used.

The arithmetic function **bit** (value,bit) is used to "read" set bits while **bitcnt** (value, bits) gives the count of bits set in a variable.

### Example

One-bit flags in the 4-byte variable *correct* are used to keep track of the judgement for the 25 questions given a student. *index* contains the current question number. The questions are in the array *prob()* and the answers are in the array *answ()*. After the exam is completed, the **bitcnt** function is used to show the number of correct answers.

```

* loop through all 25 questions, show the question, get the
* answer, and set the flag appropriately
10 loop index <= 1, 25
. at 5:3
. showa prob(index) $$ display the question
. arrow 20:3
. answer «showa, answ(index)»
15 . . setbit correct, index, 1 $$ ok
. no
. . setbit correct, index, 0 $$ wrong
. . judge quit $$ exit the arrow
. endarrow
20 . erase , $$ clear screen for next question
endloop
*
at 25:3
write The number correct is « s,bitcnt(correct,25) ».
```

**setc**

Selectively sets variables to a list of values.

---

**setc**     *SELECTOR* ; variable  $\Leftarrow$  value/s; value/s; ...  
              variable     starting variable to assign list of values

---

5        **Description**

The selective form of **set**. Based on the value of the selector, **setc** selects one of the lists of values in the tag and assigns those values to consecutive variables.

Each list of values must be separated with a semicolon (;). Values within a list must be separated with a comma (,). A null value is used to skip an assignment. The tag of **setc** may be  
 10     continued in the tag field of subsequent lines.

The starting variable need not be an array; consecutive following bytes of variable space are assigned based on the length and the type of the initial variable.

**Example**

Selectively assign a series of values to an array based on *flag*.

```

15 define local
 array(10), 4
 flag, 1
 define end
 *
20 setc flag, array(1) \Leftarrow 1,2,3,4;
 4,3,2,1;;1,2,,8

```

The **setc** command above is equivalent to the following commands:

```

if flag < 0
. calc array(1) \Leftarrow 1

```

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```

. calc array(2) <= 2
. calc array(3) <= 3
. calc array(4) <= 4
elseif flag = 0
5 . calc array(1) <= 4
. calc array(2) <= 3
. calc array(3) <= 2
. calc array(4) <= 1
elseif flag = 1 $$ skipped selection
10 elseif flag >= 2
. calc array(1) <= 1
. calc array(2) <= 2
. calc array(4) <= 8
endif

```

15        Note that in the last list assignment, array(3) is skipped.

## show

**Displays variables or numeric expressions.**

---

|                 |                                                                  |
|-----------------|------------------------------------------------------------------|
| <b>show</b>     | expression [ ,field [ ,right ] ]                                 |
| <b>write</b>    | «show   s , expression [ ,field [ ,right ] ]»                    |
| 20 <b>field</b> | maximum number of digits to display, including any decimal point |
| <b>right</b>    | number of digits to display to the right of the decimal point    |

---

## Description

Displays the value of a numeric variable or expression. Optional tags control the format of the numeric display. Values are displayed left-justified in the field and the screen location is



updated to the character position following the last character displayed (without leading blanks or trailing zeroes).

The number of digits to the left of the decimal point is the value of *field* minus the value of *right* minus 1

5        **show** displays special symbols to indicate the following error conditions:

\*\*\*\*\*        The number to display does not fit in the specified field.

??????        The number is invalid. This is usually the result of an illegal floating point operation.

If the optional tags are omitted the following default values are used:

| IF the variable is        | Then default <i>field</i><br>and <i>right</i> are. |
|---------------------------|----------------------------------------------------|
| 1-4 byte integer          | 20,0                                               |
| 8 byte interger and reals | 24,3                                               |

10        Examples

### Example 1

Displays 10 quiz scores.

```

at 3:5
write Here are your last 10 quiz scores:
15 loop index ← 1, 10
 . at index+5:10
 . show quizscor(index)
endloop

```

### Example 2

20        Through use of an embedded **show** command in a write statement, a pagination title is put at the top of the display.

```

1
*
at 1:65
write Page « show,page » of 50.

```

## 5 **showa**

**Displays text stored in a variable.**

---

|              |                               |
|--------------|-------------------------------|
| <b>showa</b> | buffer [ ,length ]            |
| <b>write</b> | «showa   a, buffer [ length]» |

---

### **Description**

10        Displays the contents of a variable buffer as alphanumeric characters for *length* characters. If *length* is omitted, the defined length of the buffer is used. The contents of any numeric variable can be shown, even if it contains non-numeric information.

After a **showa**, the current screen location is updated to the character position following the last character displayed. Any changes to plotting parameters resulting from escape code

15        sequences in the displayed text remain in effect after the **showa**.

### **Examples**

#### **Example 1**

The user's name is stored in *stuname* and then displayed using **showa**:

```

define local
20 stuname, 20 $$ user name
define end
*
at 3:3
write Please enter your name.

```

```

long 20
arrow 4:3
storea stuname, zcount
ok
5 endarrow
at 8:3
write Thank you, $$$ keep the trailing space
showa stuname, zcount
write . $$ put the period on the end

```

## 10 Example 2

Displays the name of the current lesson and unit in the upper left corner:

```

at 1:1
write « a,zlesson »:« a,zunit »

```

## showh

### 15 Displays data in hexadecimal notation.

---

```

showh buffer [,length]
write « showh | h , buffer [,length] »

```

---

#### Description

Displays data in hexadecimal form for *length* digits. If *length* is omitted, enough digits are used to display the entire defined length of the variable. Each byte of a variable shows as two hexadecimal digits. Any length variable can be displayed.

After a **showh**, the current screen location is updated to the character position following the last character displayed.

**Example**

Displays the exact hexadecimal contents of a real variable.

```

define local
float, 8, real $$ a real variable
5 define end
*
calc float \leftarrow π $$ the value of pi
at 5:3
write π looks like this in "hex".
10 at 6:3
showh float

```

**showt**

Displays a numeric variable or expression in tabular format.

---

|                 |                                                                                     |
|-----------------|-------------------------------------------------------------------------------------|
| <b>showt</b>    | variable [ ,field [ , right ]]                                                      |
| 15 <b>write</b> | « <b>showt</b>   t, variable [ ,field [ ,right ] ] »                                |
| <b>field</b>    | total size of display field including leading spaces, digits, and any decimal point |
| <b>right</b>    | number of digits to right of decimal point                                          |

---

**Description**

Displays the value of a numeric variable or expression in a tabular right-justified format by inserting leading spaces and trailing zeroes as needed to fill the desired field.

After **showt**, the current screen location is updated to the character position following the last character displayed.

## Default Values

If the optional tags are omitted, the following default values are used:

| IF the variable<br>is...     | Then default <i>field</i> and<br><i>right</i> are... |
|------------------------------|------------------------------------------------------|
| 1-4 byte integer             | 8,0                                                  |
| 8 byte integers and<br>reals | 12,3                                                 |

showt displays special symbols to indicate the following error conditions:

- 5           \*\*\*\*\*     The number to display does not fit in the specified field.  
          ??????     The number is invalid. This is usually the result of an illegal floating point operation.

### Example

Displays some entries in a table.

```

define local
10 rate(4) , 8 , real $$ pay rates end
define end
*
calc rate(1) <= 4.05
 rate(2) <= 12.76
15 rate(3) <= 8.63
 rate(4) <= 5.25
at 5:3
write Your payroll situation now looks like this:
at 7:3
20 write EMPLOYEE HOURLY RATE YEARLY SALARY
at
8:30

```

```

write Anderson
 Carmen
 Engdahl
 Lillith
5 at 8:18
write «t,rate(1),5,2»
 «t,rate(2),5,2»
 «t,rate(3),5,2»
 «t,rate(4),5,2»
10 at 8:31
write $«t,rate(1)*2080,8,2»
 $«t,rate(2)*2080,8,2»
 $«t,rate(3)*2080,8,2»
 $«t,rate(4)*2080,8,2»

```

## 15 **showv**

Displays text buffer including null codes.

---

|              |                                           |
|--------------|-------------------------------------------|
| <b>showv</b> | buffer [ ,length ]                        |
| <b>write</b> | « <b>showv</b>   v , buffer [ ,length ] » |

---

### Description

20        Displays the contents of a buffer as alphanumeric characters, including any null characters (hex value h00) which are converted to space codes if they are actually plotted on the screen.

Unlike **showv**, the **showa** command ignores null characters.

**showv** is primarily used in its embedded form in the tag of **pack** and **put**. In this case, **showv** causes null characters to be treated like any other character and does not ignore them or

25        convert them to spaces.

After a **showv**, the current screen location is updated to the character position following the last character displayed.

### Example

The **showa** plots "ABC" while the **showv** plots "AB C".

```

5 define local
 var, 4
 define end
 *
 calc var ← h41 42 00 43 $$ A B null C
10 at 10:10
 showa var $$ ABC
 at 11:10
 showv var $$ ABC

```

### status

15       **Saves and restores display status information.**

---

**status** keyword...

|                 |                                                |
|-----------------|------------------------------------------------|
| <b>save</b>     | saves current display settings in memory block |
| <b>restore</b>  | restores display settings from memory block    |
| <b>delete</b>   | deletes named status memory blocks             |
| 20 <b>reset</b> | deletes all status memory blocks               |

---

### Description

Saves the state of the current plotting parameters (such as the foreground and erase colors, mode, font, etc.) in a memory pool block or the default buffer. The saved status can later be restored to bring all plotting parameters back to their previous state. **status** can be used to

maintain the plotting parameters over a subroutine call, or to provide a common look to all main units of a lesson by resetting the defaults. Restore options allow for the reinstatement of the system **standard** settings or the settings at the previous **arrow** in a unit.

**status** saves and restores these items:

- 5       •       current screen location
- margins (both left and right)
- all loaded fonts, including current and standard fonts
- palette (if requested)

The settings of the following commands are also saved and restored by **status**. They are shown with their system **standard** settings that can be set to as a block with the **status restore;standard** option (or with the **initial** command).

- blink       off
- color       white
- colore      black
- 15       •   colorg      black
- disable     cursor
- enable      font
- font        standard; standard
- mode        write
- 20       •   origin      0,0
- rotate      0
- scale       1,1
- text        align; baseline



bold; off  
 delay; 0  
 direction; right  
 increment; 0,0  
 5 italic; off  
 margin; wrap  
 narrow; off  
 reveal; off  
 rotate; 0  
 10 shadow; off,white  
 size; 1  
 spacing; fixed  
 underline; off,foregnd  
 • thick off

15 **status save; 'NAME' | local [; palette ]**

**status save; default [; palette ]**

Saves the current plotting status in a memory pool block or the **default** buffer. The name can be either a text literal or contained in a variable. Named blocks can be restored later in any unit. The **palette** modifier causes the current palette settings to also be saved.

20 The **local** keyword saves the status in a memory pool block specific to the current unit. A local block can be restored only in the unit which saved it; it is deleted automatically when execution of the unit ends.

Saving the status to the **default** buffer makes it the default for all new main units entered by a **jump** branch.

The memory pool is used by the commands: **memory**, **image**, **window**, **status**, **area**, **flow**, **font** and **perm**. Memory blocks are tagged as belonging to a specific command type at creation and cannot be accessed by other commands using the memory pool; different commands can use the same name for a memory block without conflict.

### 5      **Example 1**

Plotting parameters are initialized in this **+initial** control block then saved in the default status buffer. These settings become the defaults for all subsequent main units that are reached by a **jump** branch. The **erase** command is used to bring the screen to the blue background even for the first branch into this lesson.

```

10 * in control block +initial
 initial
 color yellow
 colore blue
 size 2
15 font geneva
 status save; default
 erase

```

### **Example 2**

Saves the current plotting parameters and palette in the memory pool under the name

```

20 status1.
 status save; 'status1'; palette

```

**status restore; 'NAME' | local [; delete ]**

**status restore; default | arrow**

**status restore; standard**

Replaces the current plotting status with a previously saved set. If the palette was originally saved, it is restored. Optionally, the named or **local** block can be deleted from the memory pool by using the **delete** modifier

The **arrow** option restores the status in effect when the last **arrow** command was encountered. The palette is not restored.

The **standard** option restores the system standard plotting status, excluding the palette.

To restore the standard palette use **palette init**.

### Example 1

Restores the default plotting parameters (those last saved by a **status save;default** statement).

```
status restore; default
```

### 15 Example 2

Saves and restores the plotting and palette settings over a library call. The library routine can alter the display settings as desired without affecting the calling program upon return.

Alternately, the **status save** and **restore** could be built into the library routine to provide a more easily used tool.

```
20 status save; local; palette
```

```
library routines, graph
```

```
status restore; local
```

### Example 3

Restores the settings whose name is contained in the variable *mystat*. The memory block is then deleted.

**status**    **restore; mystat; delete**

**status delete; 'NAME' | local**

Deletes a saved status block from the memory pool.

**Example**

5                    Deletes the *page1* set of saved settings from the memory pool.

**status**    **delete; 'page1'**

**status reset**

Deletes all named status blocks from the memory pool. The **default**, **local**, **arrow**, and **standard** buffers are unaffected.

10            **System Variable**

**zreturn**

- 1                    Operation successful
- 6                    Duplicate name
- 10                   Name does not exist (no previous status save)
- 15            16                   Invalid name
- 18                   Insufficient memory in memory pool

**text**

**Controls text attributes.**

---

|             |                |                              |
|-------------|----------------|------------------------------|
| <b>text</b> | keyword...     |                              |
| 20          | <b>size</b>    | selects sized fonts 2        |
|             | <b>bold</b>    | selects bold fonts 3         |
|             | <b>italic</b>  | selects italic fonts 4       |
|             | <b>narrow</b>  | selects narrow fonts 4       |
|             | <b>spacing</b> | controls character spacing 4 |

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|    |                  |                                                   |    |
|----|------------------|---------------------------------------------------|----|
|    | <b>shadow</b>    | controls drop shadowing                           | 5  |
|    | <b>underline</b> | controls underlining                              | 6  |
|    | <b>delay</b>     | sets delay time between characters                | 7  |
|    | <b>increment</b> | adds extra spacing between characters             | 7  |
| 5  | <b>rotate</b>    | rotates text baseline                             | 7  |
|    | <b>direction</b> | controls plotting direction relative to baseline  | 8  |
|    | <b>margin</b>    | controls text wraparound at margin                | 9  |
|    | <b>align</b>     | controls alignment between fonts                  | 10 |
|    | <b>reveal</b>    | displays rather than functions uncover text codes | 12 |
| 10 | <b>measure</b>   | initializes text extent measurements              | 12 |
|    | <b>info</b>      | returns text attribute information                | 13 |

**Description**

Alters the way text appears on the screen. Text attributes are initialized to system defaults by the **initial**, **screen** or the **status restore; standard** commands. After selecting text attributes for a particular lesson, the modified settings can be saved and later restored by the **status** command. If the modified settings are saved in the **default** status buffer (say, by programming in the **+initial** control block), they will become the starting text attributes for any unit branched to by a **jump**.

While entering a line of text in the Source Editor, most of the **text** attributes can be manipulated directly in the text string through using uncover escape codes or the embedded command syntax. Following are the escape codes:

**COLORS**

black / black+ (gray)  
 blue / blue+  
 green / green+

**Escape Code**

a / A  
 u / U  
 g / G

cyan / cyan+  
 red / red+  
 magenta / magenta+  
 brown / brown+ (yellow)  
 white / white+

c / C  
 r / R  
 m/M  
 b/B  
 w / W

**PLOTTING MODES**

erase  
 inverse  
 noplot  
 rewrite  
 write  
 xor

**Escape Code**

-  
 !  
 -  
 =  
 +  
 \*

**FONTS**

font number 1 - 9  
 font number 10 - 35  
 font standard / text start

**Escape Code**

f 1 - 9  
 f a - z  
 f @ / &

**FONT CONTROL**

bold on / off  
 italics on / off  
 shadow on / off  
 shadow color  
 underline on / off  
 underline color

**Escape Code**

F b / B  
 F i / I  
 F s / S  
 F / color  
 F u / U  
 F \_ color

**FUNCTIONS**

size 1 - 9  
 spacing variable / fixed  
 narrow on / off  
 status default / text start  
 erase color  
 margin wrap / release  
 margin advance / set left

**Escape Code**

l - 9  
 v / V  
 n / N  
 @ / &  
 d color  
 > / <  
 CR / l

**CHARACTER FUNCTIONS**

non-breaking space  
 non-breaking hyphen  
 new line  
 continued write

**Escape Code**

#  
 h  
 \  
 |

The **size**, **bold**, **italic** and **narrow** attributes either synthesize their effects starting with an individual font or select the best font match from a font group. See the font command and the

system variables **zfontf** and **zfontret** for more information on how fonts are selected from a font group to best match the attribute settings.

**text size; size**

Controls the size attribute; the default is **size 1**.

- 5 For a font, up to a 4-time enlargement of the base size character is synthesized in both the horizontal and vertical dimensions. For a font group, the system attempts to select an appropriately sized font in the group up to a maximum size of 9. If the size doesn't exist as a font in the group, sizes up to 4 are synthesized while larger sizes default to 1.

#### Example 1

- 10 If used with a font, character doubling from the base font is synthesized. If used with a font group, the appropriate size 2 font in the group is used; if none exists, it is synthesized from the base size 1 font.

**text size; 2**

#### Example 2

- 15 Size is one of the text attributes that can be embedded into a line of text by use of the « and » embed symbols. The embed method has advantages over escape codes in that the text is not altered for viewing in the Source Editor and makes for a better printout of the coding.

**write «size,1»Start out small, «size,2»end up big.**

**text size; sizeX,sizeY**

- 20 Sizes the horizontal and vertical character enlargement independently up to the maximum size value of 4. For unequal X and Y values, the characters are always synthesized. For equal X and Y values, the characters either come from a matched font of an active font group or are synthesized.

**Example**

A 4-by-4 matrix of X's appears showing the 16 sizes of character enlargement that can be synthesized for the two argument form of **size**. *letters* should be a font and not a font group otherwise the four  $sizeX = sizeY$  entries would attempt to match and use a group font that would not match in style the other synthesized sizes.

```
font 'letters'
loop sizeX ← 1,4
. loop sizeY ←1,4
. . at 4*sizeX+1: 4*sizeY+1
10 . . text size; sizeX,sizeY
. . write X
. . endloop
endloop

text bold; on | off | CONDITION
```

15 Controls the bold attribute; the default is **off**.

**Example 1**

The font *big* is made bold by having each pixel in a character horizontally duplicated.

```
font big' $$ a font block
text bold; on
20 write This text is synthesized bold.
```

**Example 2**

In the **+initial** control block, the **initial** command sets all the plotting parameters including the font to the system standard. Several text attributes are then changed and saved in the **default** status buffer. Any **jump** branch now resets to these default text attribute settings.

25 Since the system standard font is a font group, the **bold** attribute selects a bold font from this group.



\* in +initial block

initial

text bold; on

text spacing; variable

5 ...

status save; default

text italic; on | off | CONDITION

Controls the italic attribute; the default is **off**.

### Example

10 The escape codes for turning italic on and off have been inserted around the word *amorous*. In the Source Editor, these are input by pressing [CTRL] [A] [I] and [CTRL] [A] [SHIFT] [I]. The italics are either synthesized from the current font or, if a font group is active, come directly from the appropriate italic font in the group

write The word *amorous* is derived from Latin.

15 text narrow; on | off | CONDITION

Controls narrow font usage from a font group; the default is **off**.

The **narrow** attribute is of use for low resolution screens like the CGA in order to produce the maximum amount of text on a screen. Narrow fonts are supplied in the system standard font group to provide for upward compatibility with previous versions of the TenCORE  
20 system. **narrow** cannot be synthesized.

text spacing; fixed | variable | spacing

Controls character spacing; the default is **fixed**.

With **fixed** spacing, each character occupies the same horizontal space defined as the maximum character width for a font. It is often used to align tables of numbers or to produce  
25 emphasis.

With **variable** spacing, each character occupies only the horizontal space required. For example, the lower case *i* occupies less horizontal space than the upper case *M*. Many more characters per line can be plotted with **variable** spacing than with **fixed**. Studies show that **variable** spacing increases reading speed.

- 5           The variable tag form uses the values: -1 = variable, 0= fixed.

### Example 1

When used with the standard font, the second line of text with variable spacing takes up less space on the screen than the first line with fixed spacing.

```

at 10:1
10 text spacing; fixed
write This text runs to here.
at 11:1
text spacing; variable.
write This text runs to here plus.
```

### 15       Example 2

Variable spacing is used for the labels but fixed spacing solves the problem of lining up the numbers.

```

at 6:10
text spacing; variable
20 write Pork
 Beef
 Chicken
at 6:20
text spacing; fixed
25 write 365
```

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**text shadow; on | off | CONDITION [,COLOR ]**

Controls character drop shadowing; the default is **off**. The shadow color defaults to **white**.

- 5           The shadow effect is produced by displaying each character twice: the first plotting is offset and in the shadow color while the second is in the foreground color. The drop shadow offset for a font is set in the Font Editor. If no shadow color is specified, the last specified color is used. The default shadow color is **white** after an **initial** command.

### Example

- 10           Gives a very patriotic effect for an American display.

**colore blue**

**erase**

**color white+**

**text shadow; on,red+**

- 15 **text size; 2**

**at 10:10**

**write An American statement.**

**text underline; on | off | CONDITION [,COLOR | foregnd ]**

- 20           Controls character underlining, the default is **off**. The color of an underline defaults to the current foreground (keyword **foregnd**) color as used for plotting the character.

The location of the underline and the size of the descender gap is specified for a font in the Font Editor. If no underline color is specified, the last specified underline color is used. The default underline color is **foregnd** after an **initial** command.

**Example**

Underlines the first sentence with the foreground color and the second sentence with blue.

Using escape codes in the text is an alternate method for turning on underlining.

```
text underline; on,foregnd
5 write This text is underlined in the same color as the text.
text underline; on, blue
write This text is underlined in blue.
text delay; seconds [;break]
```

Delays for the specified time in seconds after plotting each character; the default is 0.

- 10 Presence of the optional **break** modifier allows any break modified flow event to occur rapidly when a long delayed text statement is executing: the delay is temporarily turned off for the remainder of the output allowing the command to quickly complete so that the flow branch can occur.

**Example**

- 15 Causes the message to come on the screen slowly (a quarter second delay between each character).

```
text delay; 0.25
text size;2
color red+
20 write WARNING!
text increment; x,y
```

Adds an additional spacing offset after plotting a character; the default is 0,0.

After plotting a character, the *x* offset is added to the horizontal location and the *y* offset is added to the vertical location. Negative offset values are allowed.

**Example**

Causes each successive character to be plotted 2 pixels to the right and 3 pixels lower than its normal position.

```
text increment; 2,-3
```

```
5 write Descending text!
```

```
text rotate; degrees
```

Rotates the character plotting baseline in degrees; the default is 0.

For best results, use rotations that are a multiple of 90 degrees on screens that have a 1:1 aspect ratio (generally type VGA or EVGA).

10      **Example 1**

Rotates the character plotting baseline by 90 degrees counter-clockwise so that the word *TEMPERATURE* can be the label for the vertical axis of a graph.

```
at 250,200
```

```
text rotate; 90
```

```
15 write TEMPERATURE
```

**Example 2**

Four copies of the alphabet appear rotated around the center of the screen.

```
loop angle ⇐ 0, 270, 90
```

```
. at zxmax/2, zymax/2
```

```
20 . text rotate; angle
```

```
. write ABCDEFGHIJKLMNOPQRSTUVWXYZ
```

```
endloop
```

```
text direction; right | left | up | down | direction
```

Controls the direction that text will be displayed relative to the character plotting baseline;

25 the default is **right**.

The character grid is not rotated unless done by a previous **text rotate** statement.

The direction that characters will be displayed is specified by keywords (or variable value):

|   |              |       |                    |
|---|--------------|-------|--------------------|
|   | <b>right</b> | (0)   | from left to right |
| 5 | <b>left</b>  | (180) | from right to left |
|   | <b>up</b>    | (90)  | from bottom to top |
|   | <b>down</b>  | (270) | from top to bottom |

With direction set to **left**, various leftward plotting languages such as Arabic and Hebrew can be displayed when using the proper font.

#### 10      **Example**

```
text direction; left
text delay; .1
write drawtfel gniog
```

Causes the phrase *going leftward* to slowly appear on the screen starting from its right  
15      end.

```
text margin; advance | release | wrap | wordwrap | margin
```

Controls the behavior of text going past the right margin or the edge of the screen or window; the default is to **advance** character plotting to the next line.

The **advance** option is the default for displaying lines of text. It pre-checks whether any  
20      part of a character would plot past the right margin or edge of the window or screen and if so advances the character to the left margin on the next line.

The **wordwrap** option pre-checks whether any part of a word would plot past the right margin or edge of the window or screen and if so "wordwraps" the entire word to the left margin of the next line. This mode is commonly used for wordprocessing and can be accessed while

editing **write** objects in the Display Editor. Several special characters such as hard-space and hard-hyphen exist for use in wordwrap mode.

The **wrap** option causes characters and parts thereof that extend past the edge of the window or screen to wrap around to the opposite side of the screen and continue plotting: any margins set by **at** are ignored. The wrap occurs even within a character so that pieces of it may appear on both sides of the screen or window. A billboard effect can be given to animated text that wraps around the screen.

The **release** option allows character plotting to continue or start outside the window or screen: any margins set by **at** are ignored. No advance is done. If the standard clipping is in effect, only the characters and parts thereof that exist in the window appear.

The variable tag form uses the values: -1 = advance, 0 = wrap, 1 = release, 2 = wordwrap.

### Example 1

This paragraph of text  
looks just like this when

plotted in **wordwrap** mode  
by the following code.

```
screen vga
text margin; wordwrap
at 0,464;204, 0
```

```
write This paragraph of text looks just like this when plotted in wordwrap
mode by the following code.
```

### Example 2

The code below causes the text *Welcome to Aviation Basics* to cycle around the screen from left to right as if on a billboard. The **calcs** statement tests for the screen right edge and either advances the variable *x* by one or resets it to 0. The following **at** statement then advances the

starting point of the text around the screen with each iteration of the **loop**. The text in the **write** statement starts with a space which in mode **rewrite** removes the starting part of the underlying "W" from the previous iteration. If the example is changed to move to the left, the text should have the trailing space at the end.

```

5 zero x
 text margin; wrap $$ turn on screen wrap-around
 text size; 2
 mode rewrite $$ replace screen underneath
 flow jump; %other; start; break $$ provide exit on any key
10 loop
 . calcs x = xmax; x <= 0; x+1
 . at x, ymax/2 $$ half-way up screen
 . write Welcome to AVIATION BASICS $$note first space
 endloop
15 text align; baseline | bottom | align

```

Aligns characters of different sizes or fonts; the default is **baseline**.

The **align** options control how characters of different sizes or fonts plot relative to each other. This is done by lining them up either on their baselines or the bottoms of the character cell. The baseline is usually the bottom point of letters without descenders and is set in the Font Editor

20 for each font.

When **baseline** alignment is in effect, characters align along their baseline. Different sizes and styles of fonts appear to be on the same line:

yyyy very funny



When **bottom** alignment is in effect, characters align along the bottoms of their character cells. When several sizes or styles of characters are lined up by their bottoms, they don't appear to be on a common line due to the need for the descender part to grow with the size of the character

y.y.y.y very funny

5 When **baseline** alignment is in effect, the baseline in the **standard** font is used to determine the placement of characters from all other fonts on the screen. In the **standard** size 1 font, the baseline is located **zcharb** above the bottom of the character cell. For the currently selected font and size enlargement, the baseline is located **zfontb** above the bottom of the cell. Since the baselines are to line up, the current font is plotted with the bottom of its cell located  
10 **zcharb-zfontb** vertical dots from the set **zy** location where the **standard** font size 1 bottom plots.

The variable tag from uses the values: -1 = baseline, 0 = bottom

**text** reveal; off | all | allcr | editor | reveal

Controls display of hidden text codes; the default is **off**.

15 Displays rather than functions the hidden codes occurring in text such as uncover escape codes, superscripts, subscripts and the carriage return (CR). The hidden code display is either a single symbol or begins with a square followed by one to three additional characters specifying the hidden function.. The variable tag form use the values shown after the keywords.

|    |               |     |                                                    |
|----|---------------|-----|----------------------------------------------------|
|    | <b>all</b>    | (2) | displays hidden codes except CR; CR functions      |
| 20 | <b>allcr</b>  | (3) | displays hidden codes and CR; CR functions         |
|    | <b>editor</b> | (4) | displays hidden codes and CR; CR does not function |

**off** (0) return to functioning hidden codes

**text measure**

Initializes the text measuring system variables that can be used to determine the rectangular extent of a paragraph of text. The system variables define the corners of a rectangle:

5 **(zplotxl, zplotyl) ; (zplotxh, zplotyh)**

### Example

A paragraph of any width and height is framed. Multiple **write** and **show** commands can occur where the example uses a single **write**.

**text measure**

10 **write This is a paragraph**  
**of text...**

**box zplotxl,zplotyl; zplotxh,zplotyh; 2**

**text info; infoBuffer [,length]**

15 Reads information on the current settings of the text options into a buffer for the given length. If the length is not specified, the defined length of the buffer is used. The format of the buffer is:

| Text Option  | Bytes | Possible Values                       |
|--------------|-------|---------------------------------------|
| size x       | 2     | 1...9                                 |
| size y       | 2     | 1...9                                 |
| bold         | 1     | -1 = on; 0 = off                      |
| italic       | 1     | -1 = on; 0 = off                      |
| narrow       | 1     | -1 = on; 0 = off                      |
| (reserved)   | 5     |                                       |
| blink        | 1     | -1 = on; 0 = off (text.obsolete)      |
| bright       | 1     | -1 = on; 0 = off (text.obsolete)      |
| y base same  | 1     | -1 = on; 0 = off (charsets. obsolete) |
| spacing      | 1     | -1 = variable; 0 = fixed              |
| shadow       | 1     | -1 = on; 0 = off                      |
| shadow color | 4     | current shadow color                  |
| (reserved)   | 5     |                                       |
| underline    | 1     | -1 = on; 0 = off                      |
| underline    | 1     | -1 = foregnd; 0 = specific color      |

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|                 |        |                                                     |
|-----------------|--------|-----------------------------------------------------|
| underline color | 4      | current underline color                             |
| (reserved)      | 6      |                                                     |
| delay break     | 1      | -1 = yes; 0= no                                     |
| margin          | 1      | -1 = advance; 0= wrap; 1 = release; 2= wordwrap     |
| direction       | 2      | 0 = right; 90 = up; 180 = left; 270 = down          |
| rotation        | 2      | 0..359                                              |
| align           | 1      | -1 = baseline; 0= bottom                            |
| delay           | 4,real | delay in seconds                                    |
| reveal          | 1      | 0 = off; 1 = reveal* ; 2 = all; 3 =allcr; 4= editor |
| x increment     | 2      | x - increment                                       |
| y increment     | 2      | y - increment                                       |

\* for the obsolete reveal on command.

### Example

Reads the current text attribute settings and displays them.

```

define local
5 settings,54
 . sizex,2
 . sizey,2
 . bold,1
 ...
10 define end
 *
 text info; settings
 write The current X-size = «s, sizex»
 Y-size = «s, sizey»
15 and bold is
 writec bold; on; off

```

**width****Description**

Specifies a width for graphics; default is one pixel. System variable zwidth holds the current width value. Width is added symmetrically on both sides of the basic graphic elements except for dot which just grows larger.

The following commands are affected:

dot

draw

polygon (non-filled only)

10 circle (non-filled only)

ellipse (non-filled only)

box and erase are not directly affected by the width command. However, they can use the system variable zwidth for their width argument and thereby become connected. Note that these graphics only "widen" inwardly due to their pre-existing width argument definition.

15 The current width setting is part of the status buffer

**width expression**

**width 5** \$\$ following line graphics 5 pixels thick

**width var** \$\$ width depends on variable

**window**

20 **Manages display windows.**

---

**window** keyword...

**open** opens display window using relative coordinates

**openabs** like **open** except uses absolute coordinates

|                   |                                                         |
|-------------------|---------------------------------------------------------|
| <b>close</b>      | closes current window, restores previous display status |
| <b>reset</b>      | closes all windows, restores previous display status    |
| <b>frame</b>      | changes window boundaries using relative coordinates    |
| <b>frameabs</b>   | like <b>frame</b> except uses absolute coordinates      |
| 5 <b>relative</b> | controls use of window-relative coordinates             |
| <b>clip</b>       | controls clipping of graphics extending beyond window   |
| <b>compress</b>   | controls compression of saved underlying display        |

---

### Description

The **window** command opens, closes, and alters display windows. When a window is  
 10 opened, the current display status and screen display under the window is saved in the memory  
 pool. Further display operations are relative to and appear only in the window unless the absolute  
 coordinates feature is selected. When a window is closed, the previous display status and screen  
 display under the window is restored.

On entry to the system, an initial window is opened that corresponds to the entire physical  
 15 screen. Properties of this outer-level window can be altered with the **window** command but it  
 cannot be closed.

### **window open [; LOCATION [; LOCATION ]]**

Opens a display window over the rectangular area specified, saving in the memory pool  
 the screen display underneath the rectangle, the display status (see **status**), the current area  
 20 settings (see **area**), and the current setting for relative coordinates (**window relative**), clipping  
 (**window clip**) and compression (**window compress**). Upon closing the window, the saved data  
 are used to restore the screen to its previous state.

Screen coordinates are relative to the newly opened display window: the graphic  
 coordinate 0,0 is at the lower left corner of the window and the character coordinate 1:1 refers to

the first character on the top line in the window. Display objects are clipped if they extend beyond the window (see **window clip**).

The rectangular coordinates for **window** are affected by any previously opened window and the **origin** command; they are not affected by **scale**, **rotate**, or **window clip**. Use **window openabs** or **enable absolute** to locate a window relative to the physical screen without regard to any previously opened window. A window is not opened if it would extend off the physical screen (**zreturn** = 23).

When both rectangle *LOCATIONS* are blank, the entire screen or previous **window** is implied. When only one rectangle *LOCATION* (the first) is present, it denotes that the current screen location should be used for the starting position and *LOCATION* gives the number of characters or characters and lines of the currently selected font to size the window by.

### Example 1

A window opens on a VGA screen with a blue background, white border, and some text.

When any key is pressed, the window is closed and the underlying display is restored.

```

15 window open; 100,100; 400,250 $$ open window, middle of screen
 colore blue
 erase $$ clear window to blue

 color white+
20
 box ;;1 $$ put border around window edge
 at 2:4
 write The author of this lesson is:

```

Dr. John Burdeen

University of Illinois at Urbana

Press any key to continue...

pause pass=all

window close

## 5 Example 2

at 5:15

window open; 20,5

A window 20 characters wide and 5 lines deep is opened at the underlying screen (or window) location of line 5 character 15.

## 10 window openabs [; LOCATION [; LOCATION ]]

Identical to **window open** except that the rectangular location is interpreted as though **enable absolute** is in effect: the *LOCATION* coordinates refer to the physical screen and are not affected by any previously open window or the **origin** command.

**window close [; noplot ] [; noarea ]**

15 Closes the current display window, restoring from the memory pool the saved display beneath the window, the display **status**, the **area** definitions, and the status of **window relative**, **window clip**, and **window compress**. The optional keyword **noplot** inhibits the restoration of the display beneath the window. The optional keyword **noarea** inhibits the restoration of area defines.

## 20 window reset [; noplot] [; noarea]

Closes all open windows in order from the last to the first opened, restoring the display beneath the window, the display **status**, the **area** definitions, and the status of **window relative**, **window clip**, and **window compress**. The optional keyword **noplot** inhibits the restoration of the display beneath the window. The optional keyword **noarea** inhibits the restoration of **area**

25 defines.

**window frame [; LOCATION [; LOCATION ]]**

Changes the boundaries of the current display window. The contents of the window and the saved display under the window are not changed. **window frame** can be used on the outer-level physical screen window.

5 **window frameabs [; LOCATION [; LOCATION ]]**

Identical to **window frame** except that the rectangular location is interpreted as though **enable absolute** is in effect: coordinates refer to the physical screen. A previously opened window or the **origin** command have no effect.

**window relative; [ on | off | CONDITION ]**

10 Turns **on** or **off** the use of window-relative coordinates for the current display window. The default when a window is opened is relative on. If relative coordinates are turned **off**, then coordinates are relative to the physical screen rather than the current window; however, **scale**, **rotate**, **origin** and **window clipping** still apply.

For the *CONDITIONAL* form, an expression that evaluates to a negative value is treated  
15 as **on** while zero or a positive value is treated as **off**.

**window clip; [ on | off | CONDITION ]**

Turns **on** or **off** the clipping of display objects that extend outside the current window. The default when a window is opened is **clip on**. If clipping is turned **off**, objects extending outside the current window will be displayed.

20 The system variables **zclipx1**, **zclipy1**, **zclipx2**, **zclipy2** hold the absolute coordinates for the lower left and upper right of the clipping area.

**window compress; [ on | off | CONDITION ]**

Controls data compression of the underlying screen. The default when a window is opened is **compress on**. When a window is opened, the contents of the display under the window



is saved in the memory pool. When window compression is set **on**, the saved data occupies considerably less memory pool space; when compression is set **off**, more space is used in the memory pool but on older model computers the window may open and close more quickly.

### System Variables

5      **zreturn**

- 1                      Operation successful
- 18                     Insufficient memory in memory pool
- 23                     Part of window off physical screen

### Miscellaneous

10      The following system variables are affected by window

**zdispx**                width and height of window

**zdispy**

**zxmax**                maximum x- and y-coordinates in window

**zymax**

15      **zwindowx**            absolute x- and y-coordinates of lower left window corner

**zwindowy**

**zclipx1**              absolute x- and y-coordinates of lower left clipping area

**zclipy1**

**zclipx2**              absolute x- and y-coordinates of upper right clipping area

20      **zclipy2**

**write**

**Displays text.**

---

```
write TEXT
```

---

**Description**

5        Displays text on the screen beginning at the current screen location. The location is usually set by a preceding **at** command which can also set left and right text margins. The text of the **write** can extend for many lines whose wraparound behavior is controlled by the **text margin** command.

10       Text attributes (e.g., color, underline, drop shadow, font design, etc.) can be changed character-by-character through use of embedded text attributes. These can occur in the text as: uncover code sequences that are inserted through menu options in the source code and display editors; and embedded commands that are included through use of the embed symbols « ».

50       Over 50 text attribute uncover codes exists. The commands and **text** command keywords that can embed attributes are:

|    |                            |                                               |
|----|----------------------------|-----------------------------------------------|
| 15 | <b>color</b>   <b>c</b>    | selects foreground display color              |
|    | <b>colore</b>   <b>ce</b>  | selects background display color              |
|    | <b>margin</b>   <b>ma</b>  | controls text wrapping                        |
|    | <b>mode</b>   <b>m</b>     | selects how text plots over existing displays |
|    | <b>size</b>   <b>s</b>     | changes size of fonts                         |
| 20 | <b>spacing</b>   <b>sp</b> | selects proportional or fixed spacing         |

The text attributes that exist at the start of a **write** are saved and restored at the end of the **write** so that any attribute changes made within the text do not extend to following commands.

These starting saved attributes can be restored to at any time within the text by use of the "status

text start" uncover code sequence Esc-&. A **writex** variant of this command does not save the starting text attributes: it restores attributes to those saved by the previous **write** command.

The display of the contents of variables and buffers can also be embedded in the text of a **write** by using the embedded form of **show** commands:

- 5        **show** | **s**        displays a variable or expression
- showa** | **a**       displays text in a buffer
- showh** | **h**       displays a buffer in hexadecimal format
- showt** | **t**       displays a variable in tabular format
- showv** | **v**       displays a text buffer including null codes
- 10       Trailing spaces on a line of text are normally stripped off by the compiler: they can be included by ending the line with a triple dollar sign comment (\$\$\$).

## Examples

### Example 1

- 15       The following write goes on for three lines in source code. However, it will be displayed for many more lines on the screen since the margins as set by the **at** command make for a very narrow paragraph.

```

at 1:10; 10:30 $$ left margin is char 10
 $$ right margin is char 30

text margin;wordwrap $$ wrap full words at right margin
20 write This is a paragraph of text that goes on and on. It will
 appear nicely between the margins as set by the preceding at
 command. Continued lines of text in a write statement begin by
 tabbing over the command field.
```

**Example 2**

Embedded show commands can display both text and numbers from variables. The following would display something like:

Bill:

5                    your score is 92%  
                     the class average was 85%.

```
write «showa, name»:
 your score is «show, score»%
 the class average was «show, average»%.
```

10      **Example 3**

```
write Special effects such as underlining and italics are easily
 put on characters through insertion of embedded code sequences
 in the editors. Some attributes such as size can use the
 embedded command form so that they «size,4» can be seen clearly
15 in «color, red+» printouts of your code.writec
```

**writec**

Selectively display text.

---

```
writec SELECTOR; TEXT; TEXT;...
```

---

**Description**

20            The selective form of the **write** command.

The delimiter first following the *SELECTOR* is used to separate all following *TEXT* cases and can be a:

semicolon        ;

colon :

comma ,

end-of-line ↵

universal delimiter |

## 5 Examples

### Example 1

The variable *month* is used to selectively pick the text for displaying a month. The first two cases (negative and zero) are not used for text.

`write Today's month is $$$ retain the trailing space`

10

`writec month,,,January,February,March,April,May,June,  
July,August,September,October,November,December`

### Example 2

Multiple lines of text can occur in each selective case. Delimiters not used as the selector

15 delimiter can occur in the text.

`writec question;;;`

`What city was once called Fort Dearborn?`

`Hint: it is also called the Windy City.;      $$ case 1`

20

`What is the largest city in the US?`

`Hint: it is on the east coast.;      $$ case 2`

`What city is known as the Gateway to the West?`

25

`Hint: it is on the Mississippi.;      $$ case 3`

...

**zero**

Zeroes a variable or a specified number of bytes.

---

zero    variable [ ,length ]

---

**Description**

- 5            Zeroes bytes of variable space. The one-tag form zeroes only the variable specified. The two-tag form zeroes any number of bytes, beginning at the specified *variable* ; variable boundaries can be crossed with this form.

**Example**

To zero a large variable with one command.

```
10 define global
 var, 128 $$ a 128-byte buffer
 define end
 *
 zero var $$ zero all 128 bytes]
```

Although the invention has been described in terms of particular embodiments and applications, one of ordinary skill in the art, in light of this teaching, can generate additional embodiments and modifications without departing from the spirit of or exceeding the scope of the claimed invention. Accordingly, it is to be understood that the drawings and descriptions  
5 herein are proffered by way of example to facilitate comprehension of the invention and should not be construed to limit the scope thereof.

## WHAT IS CLAIMED IS:

1. A method for optimally controlling storage and transfer of computer programs between computers on a network to facilitate interactive program usage, comprising:

storing an applications program in a nonvolatile memory of a first computer, said applications program being stored as a plurality of individual and independent machine-executable code modules;

in response to a request from a second computer transmitted over a network link, retrieving a selected one of said machine-executable code modules and only said selected one of said machine-executable code modules from said memory; and

transmitting said selected one of said machine-executable code modules over said network link to said second computer.

2. The method defined in claim 1 wherein said first computer is a server computer on a network, said second computer being a secondary server on said network, further comprising, in response to a user request directed to said first computer, forwarding said user request from said first computer to said second computer to initiate processing of said user request by said second computer, said selected one of said machine-executable code modules being required by said second computer to process said user request.

3. The method defined in claim 2, further comprising:

storing, in a memory of said first computer, a list of secondary servers on said network, said list including response times for the respective secondary servers;

periodically updating said response times, said updating including (a) sending echo



packets from said first computer to said secondary servers and (b) measuring, at said first computer, delays between the sending of said echo packets and a receiving of responses to said echo packets from the respective secondary servers; and

selecting said second computer from among said secondary servers as the secondary server having the shortest response time.

4. The method defined in claim 1, further comprising:

storing a list of user authentication codes in said memory;

upon receiving said request from said second computer, comparing a user authentication code in said request with said list of user authentication codes in said memory;

proceeding with the retrieving and transmitting of said selected one of said machine-executable code modules only if the user authentication code in said request matches a user authentication code in said list.

5. The method defined in claim 4 wherein said request from said second computer is contained in an encryption packet, further comprising decrypting said encryption packet prior to the comparing of said user authentication code in said request with said list of user authentication codes in said memory.

6. The method defined in claim 1 wherein said request from said second computer is a second request directed to said first computer from said second computer, further comprising:

receiving a first request directed to said first computer from said second computer via said network link, said first request asking for transmission of a first version of a particular

code module included in said machine-executable code modules;

transmitting, from said first computer to said second computer via said network link, a signal indicating that a more recent version of said particular code module is available, said selected one of said machine-executable code modules being said more recent version of said particular code module.

7. The method defined in claim 1 wherein said machine-executable code modules are written in a user-friendly programming code, further comprising translating said selected one of said code module at said second computer from said programming code into machine code directly utilizable by said second computer.

8. A method for optimally controlling storage and transfer of computer programs between computers on a network to facilitate interactive program usage, comprising:

storing a portion of an applications program in a first computer, said applications program comprising a plurality of individual and independent machine-executable code modules, only some of said machine-executable code modules being stored in said first computer;

executing at least one of said machine-executable code modules on said first computer;

transmitting, to a second computer via a network link, a request for a further machine-executable code module of said applications program;

receiving said further machine-executable code module at said first computer from said second computer over said network link; and

executing said further machine-executable code module on said first computer.

9. The method defined in claim 8, further comprising:

sending a request from the first computer to a further computer for a list of servers on said network;

after transmission of said list of servers from said further computer to said first computer, determining response times for said servers by (a) sending echo packets from said first computer to said servers and (b) measuring, at said first computer, delays between the sending of said echo packets and a receiving of responses to said echo packets from the respective servers; and

selecting said second computer from among said servers as the server having the shortest response time, the transmitting of said request for said further machine-executable code module being executed after the selecting of said second computer.

10. The method defined in claim 8 wherein said request from said first computer is a second request directed to said second computer from said first computer, further comprising transmitting a first request from said first computer to said second computer via said network, said first request being for a first version of a particular machine-executable code module of said applications program, said second request being transmitted in response to a signal from said second computer indicating that a more recent version of said particular machine-executable code module is available, said second request being for said more recent version of said particular machine-executable code module.

11. The method defined in claim 8 wherein said second computer stores at least some of said machine-executable code modules of said applications program, said second computer executing at least one of said machine-executable code modules in response to the execution of

a machine-executable code module by said first computer, whereby said first computer and said second computer engage in interactive processing via said network.

12. The method defined in claim 8 wherein said machine-executable code modules are written in a user-friendly programming code, further comprising translating said selected one of said code module at said second computer from said programming code into machine code utilizable by said second computer.

13. The method defined in claim 8 wherein said machine-executable code modules each incorporate an author identification, further comprising, in response to an instruction received by said first computer over said network and prior to executing said one of said machine-executable code modules on said first computer, determining whether the particular author identification incorporated in said one of said machine-executable code modules is an allowed identification and proceeding with the executing of said one of said machine-executable code modules only if said particular author identification is an allowable identification.

14. The method defined in claim 8 wherein the storing of said portion of said applications program in said first computer includes caching said code modules in a nonvolatile memory of said first computer.

15. The method defined in claim 8, further comprising transmitting a request from said first computer to said second computer for a machine-executable code module during an idle time on said first computer.

16. A computing system comprising:  
digital processing circuitry;  
a nonvolatile memory storing general operations programming and an applications program, said applications program including a plurality of individual and independent machine-executable code modules, said memory being connected to said processing circuitry to enable access to said memory by said processing circuitry;

a communications link for communicating data and programs over a network to a remote computer; and

a code module exchange means operatively connected to said memory and to said communications link for retrieving a single code module from among said machine-executable code modules and transferring said single code module to said remote computer in response to a request for said single code module from said remote computer.

17. The computing system defined in claim 16 wherein said computing system is a server computer on said network.

18. The computing system define in claim 17 wherein said memory contains a list of secondary servers on said network, said list including response times for the respective secondary servers, further comprising:

detection means for detecting an overload condition of the computing system; and

server selection means operatively connected to said detection means, said memory and said communications link for determining which of said secondary servers has a shortest response time and for shunting an incoming user request to the secondary server with the shortest response time when said overload condition exists at a time of arrival of said user

request.

19. The computing system defined in claim 18 wherein the secondary server to which said user request is shunted is said remote computer, said single code module being required for enabling said remote computer to process the user request.

20. The computing system defined in claim 18, further comprising updating means operatively connected to said memory and said communications link for (I) periodically sending echo packets to said secondary servers, (II) measuring delays between the sending of said echo packets and a receiving of responses to said echo packets from the respective secondary servers, and (III) updating the response times in said list in accordance with the measured delays.

21. The computing system defined in claim 17 wherein said network is the Internet.

22. The computing system defined in claim 16 wherein said memory contains a stored list of user authentication codes, further comprising comparison means for comparing a user authentication code in said request with said list of user authentication codes in said memory and for preventing code-module retrieval and transmission in the event that the user authentication code in said request fails to correspond to any user authentication code in said list.

23. The computing system defined in claim 22 wherein said request from said remote computer is contained in an encryption packet, further comprising means connected to said

communications link and said comparison means for decrypting said encryption packet prior to the comparing of said user authentication code in said request with said list of user authentication codes in said memory.

24. The computing system defined in claim 16, further comprising means for determining whether a requested code module has an updated version and for responding to said request with an invitation to said remote computer to accept the updated version of the requested code module.

25. The computing system defined in claim 1 wherein said machine-executable code modules are written in a user-friendly programming code, further comprising an interpreter for translating said programming code into machine code directly utilizable by said processing circuitry.

26. A computing system comprising:

a first computer;

a second computer remotely located relative to said first computer;

communications links at said first computer and said second computer for tying said first computer and said second computer to one another over a network,

said first computer including a nonvolatile memory storing at least a portion of an applications program, said applications program including a plurality of individual and independent machine-executable code modules,

each of the computers being provided with code module exchange means for cooperating with the code module exchange means of the other computer to transfer a single

code module from among said machine-executable code modules from said first computer to said second computer.

27. The computing system defined in claim 26 wherein said first computer is a primary server and said second computer is a secondary server on said network, said first computer including detection means for detecting an overload condition of said first computer, said first computer further including shunting means operatively connected to said detection means and the communications link at said first computer for shunting an incoming user request to said second computer when said overload condition exists at a time of arrival of said user request.

28. The computing system defined in claim 27 wherein said first computer further includes updating means operatively connected to said memory and said communications link for (I) periodically sending echo packets to a plurality of secondary servers on said network, (II) measuring delays between the sending of said echo packets and a receiving of responses to said echo packets from the respective secondary servers, and (III) updating the response times in a list in said memory in accordance with the measured delays.

29. The computing system defined in claim 26 wherein said first computer is a server computer and said second computer is a user computer.

30. A computing system comprising:

a memory storing a portion of an applications program, said applications program comprising a plurality of individual and independent machine-executable code modules, only some of said machine-executable code modules being stored in said memory;



digital processing circuitry operatively connected to said memory for executing at least one of said machine-executable code modules;

a communications link for communicating data and programs over a network to a remote computer; and

a code module exchange means operatively connected to said memory and to said communications link for communicating with a remote computer via a network link to obtain from said remote computer a further machine-executable code module of said applications program, said digital processing circuitry being operatively tied to said code module exchange means for executing said further machine-executable code module upon reception thereof from said remote computer.

31. The computing system defined in claim 30 wherein said computing system is a user computer on said network and said remote computer is a server computer.

32. The computing system defined in claim 31 wherein said memory contains a list of servers on said network, said list including response times for the respective servers, further comprising server selection means operatively connected to said memory and said code module exchange means for instructing said code module exchange means to communicate with a server selected from among said secondary servers as having a shortest response time, said remote computer being the selected server.

33. The computing system defined in claim 32, further comprising updating means operatively connected to said memory and said communications link for (I) periodically sending echo packets to said servers, (II) measuring delays between the sending of said echo

packets and receiving of responses to said echo packets from the respective servers, and (III) updating the response times in said list in accordance with the measured delays.

34. The computing system defined in claim 30, further comprising a software modified circuit operatively connected to said code module exchange means for encrypting communications transmitted to said remote computer and for decrypting communications received from said remote computer.

35. The computing system defined in claim 30 wherein said machine-executable code modules are written in a user-friendly programming code, further comprising an interpreter for translating said programming code into machine code directly utilizable by said processing circuitry.

36. A method for distributing processing among computers on a computer network, comprising:

storing an applications program in a nonvolatile memory of a first computer, said applications program being stored as a plurality of individual and independent machine-executable code modules;

executing portions of said applications program on said first computer;

transmitting a request over a network link from said first computer to a second computer not running at full capacity, said request being to take over the work load of said first computer;

in response to a request from said second computer, selectively transmitting machine-executable code modules of said applications program from said first computer to said second

computer over said network link, the transmitted code modules being less than all of the code modules of said applications program; and

operating said second computer to follow programming instructions in the transmitted code modules to assist said first computer in executing its work load.

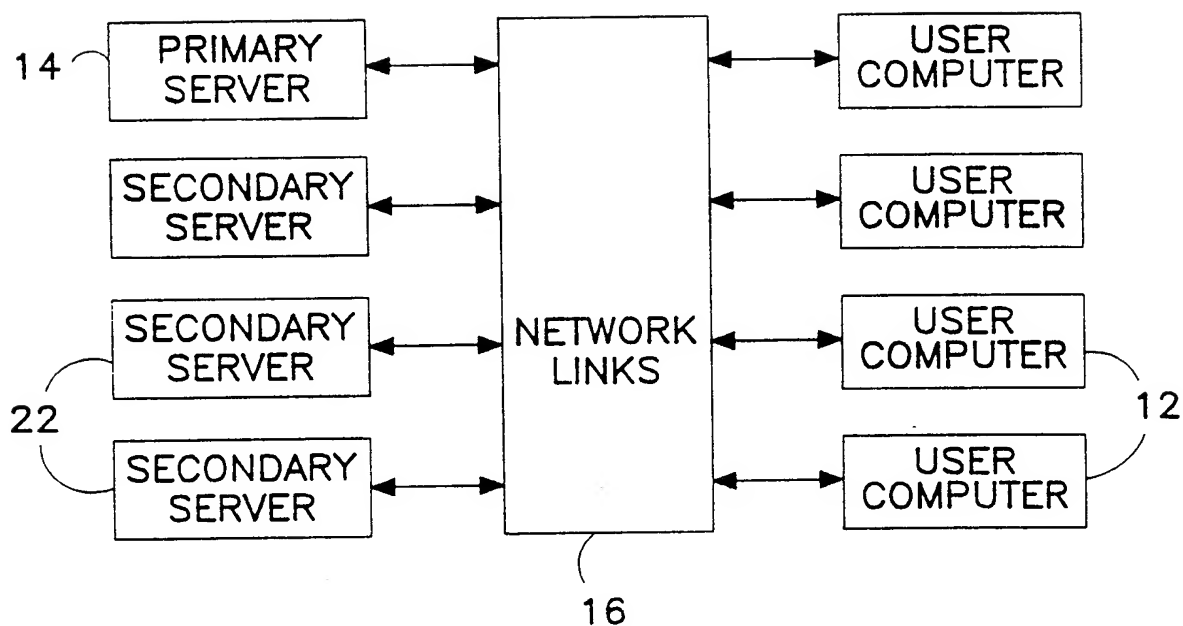


FIG. 1

FIG. 2

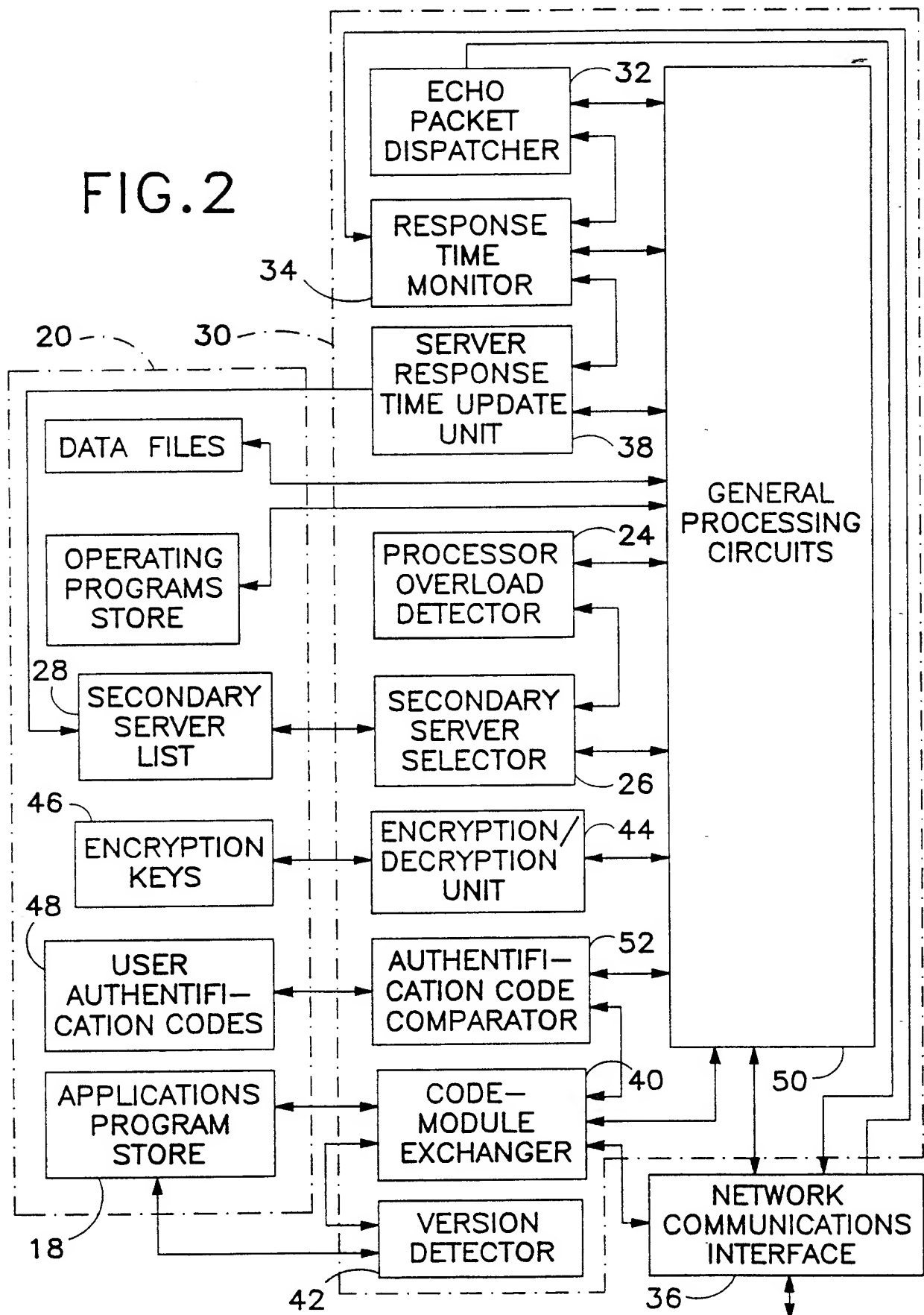
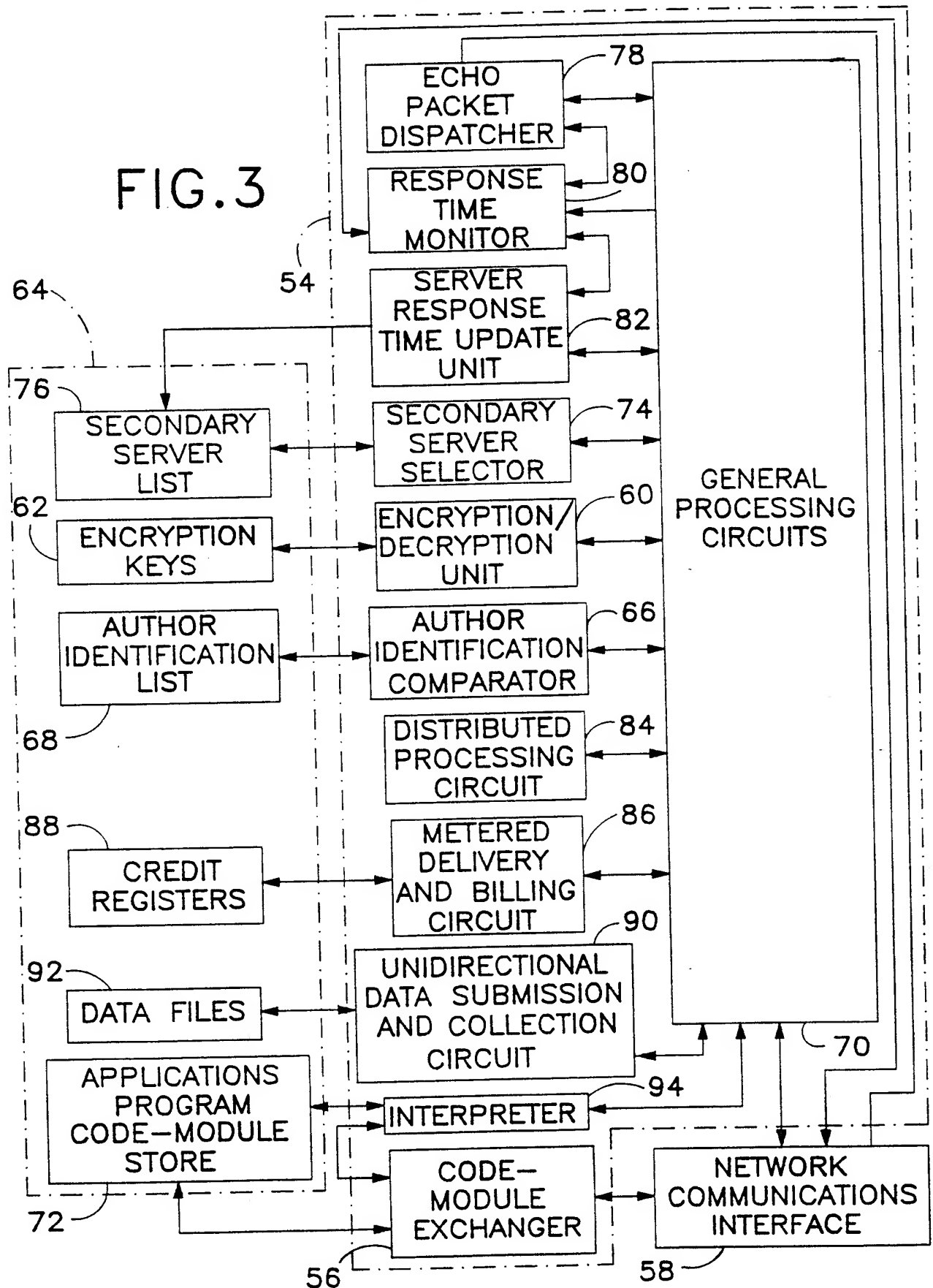


FIG. 3



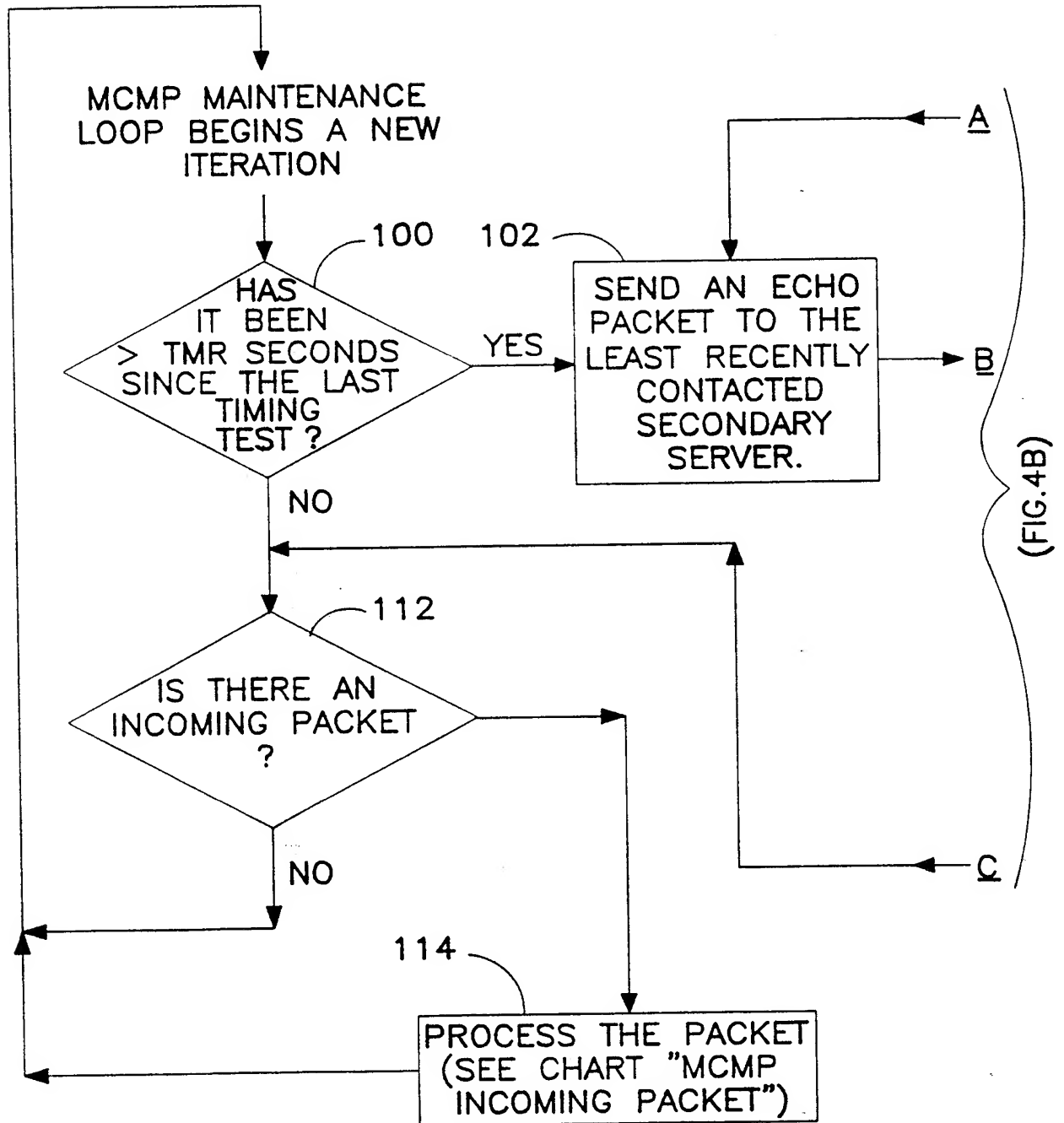


FIG. 4A

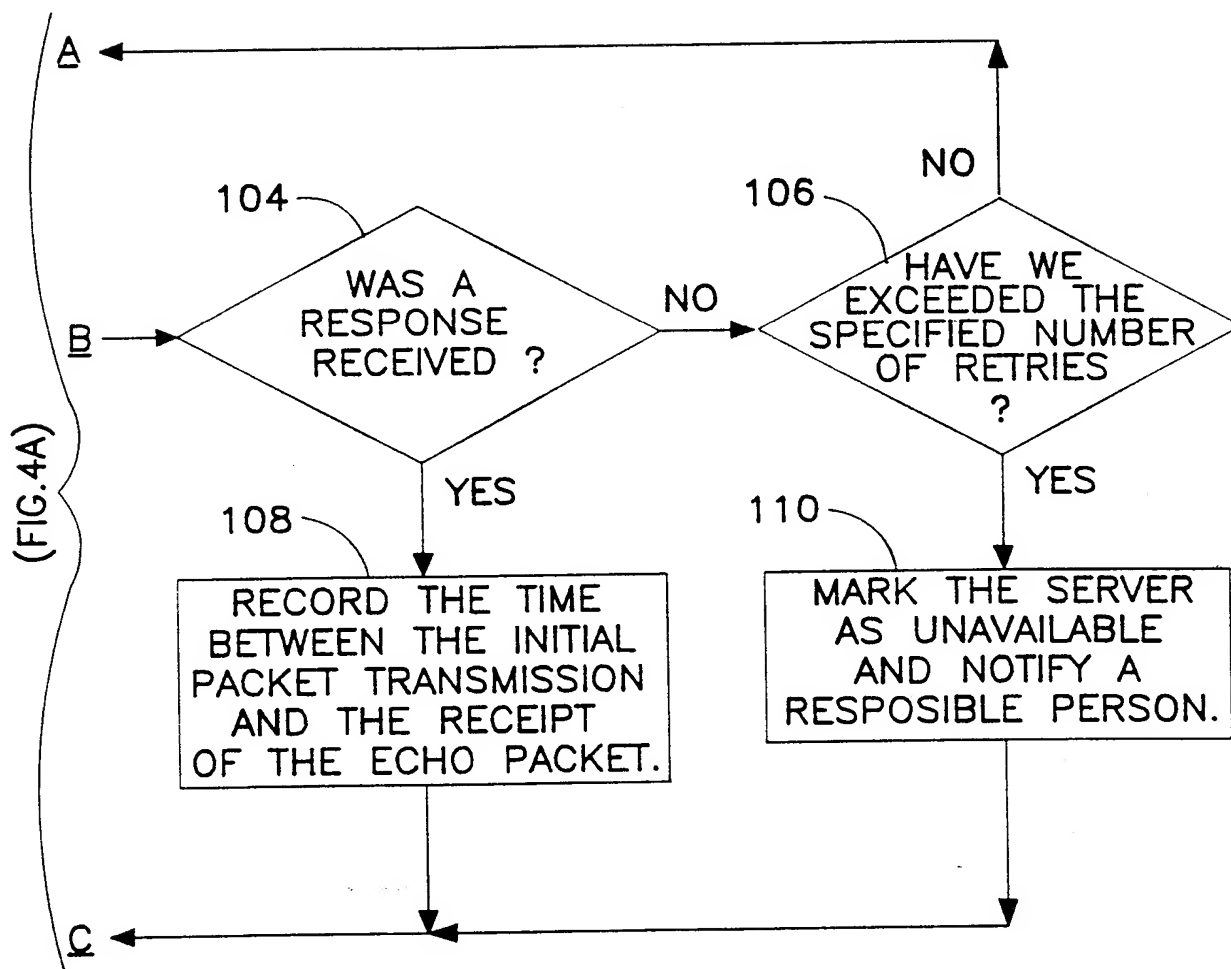


FIG. 4B



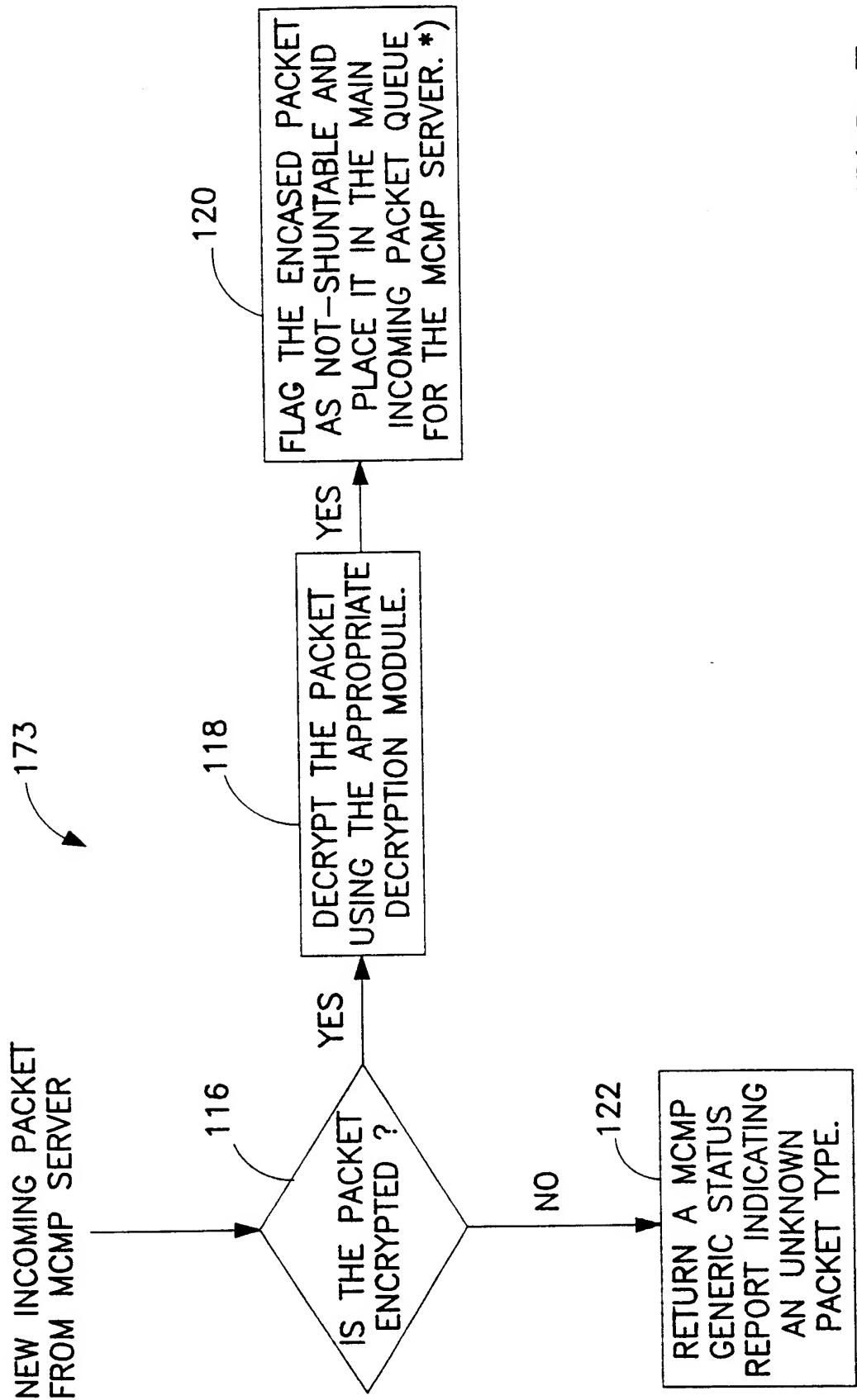


FIG.5

FIG. 6A

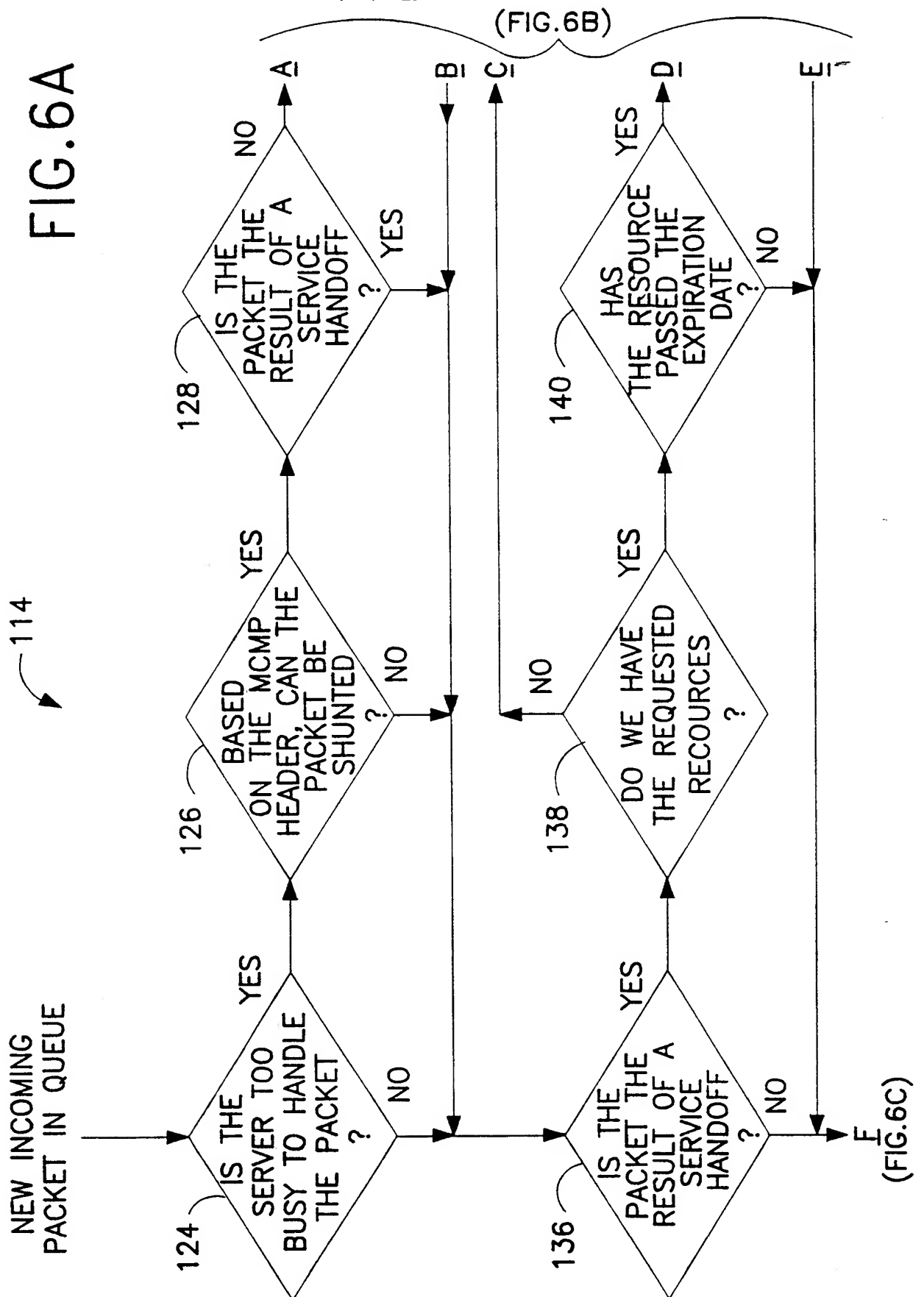
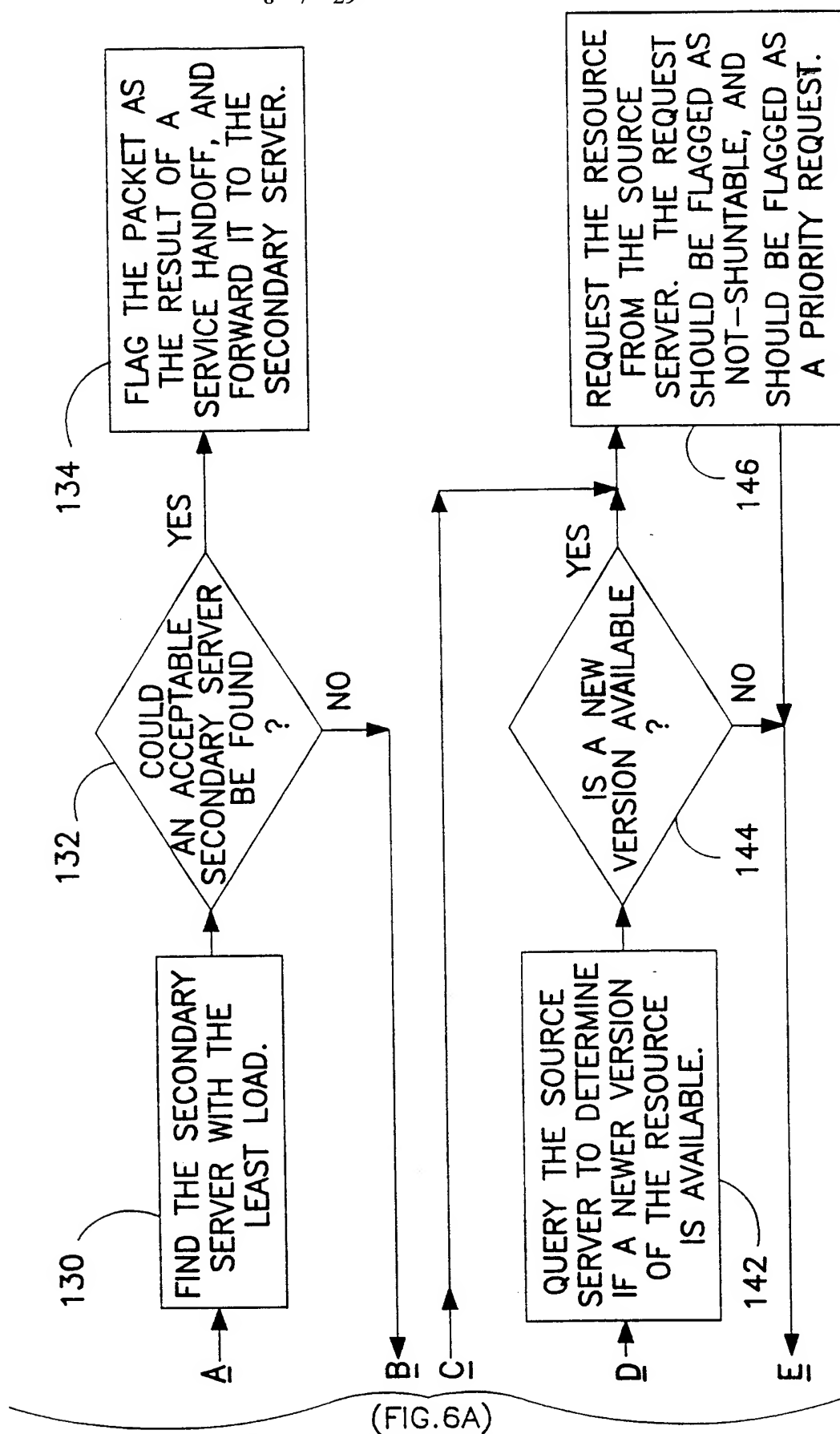
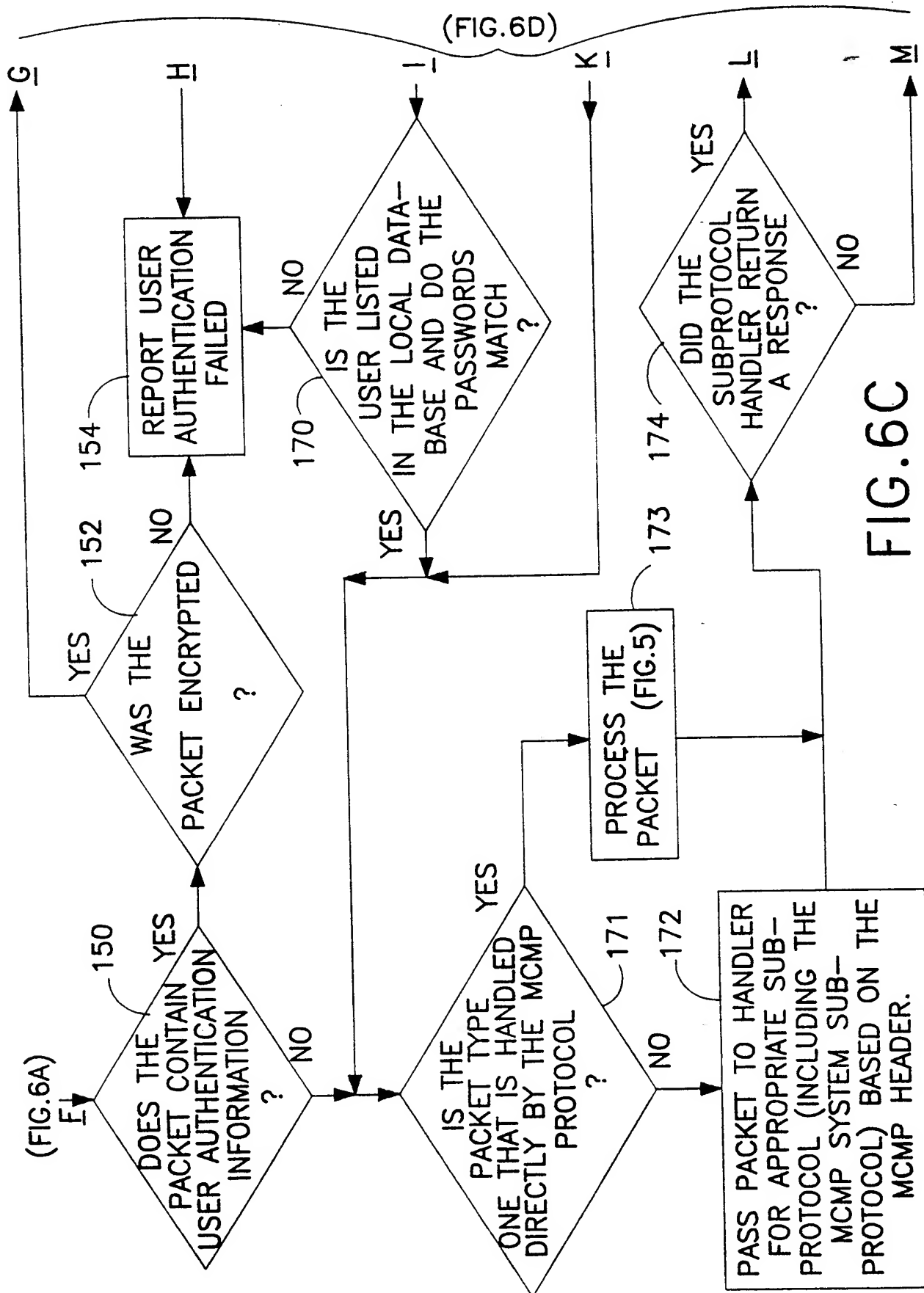


FIG. 6B





(FIG.6E)

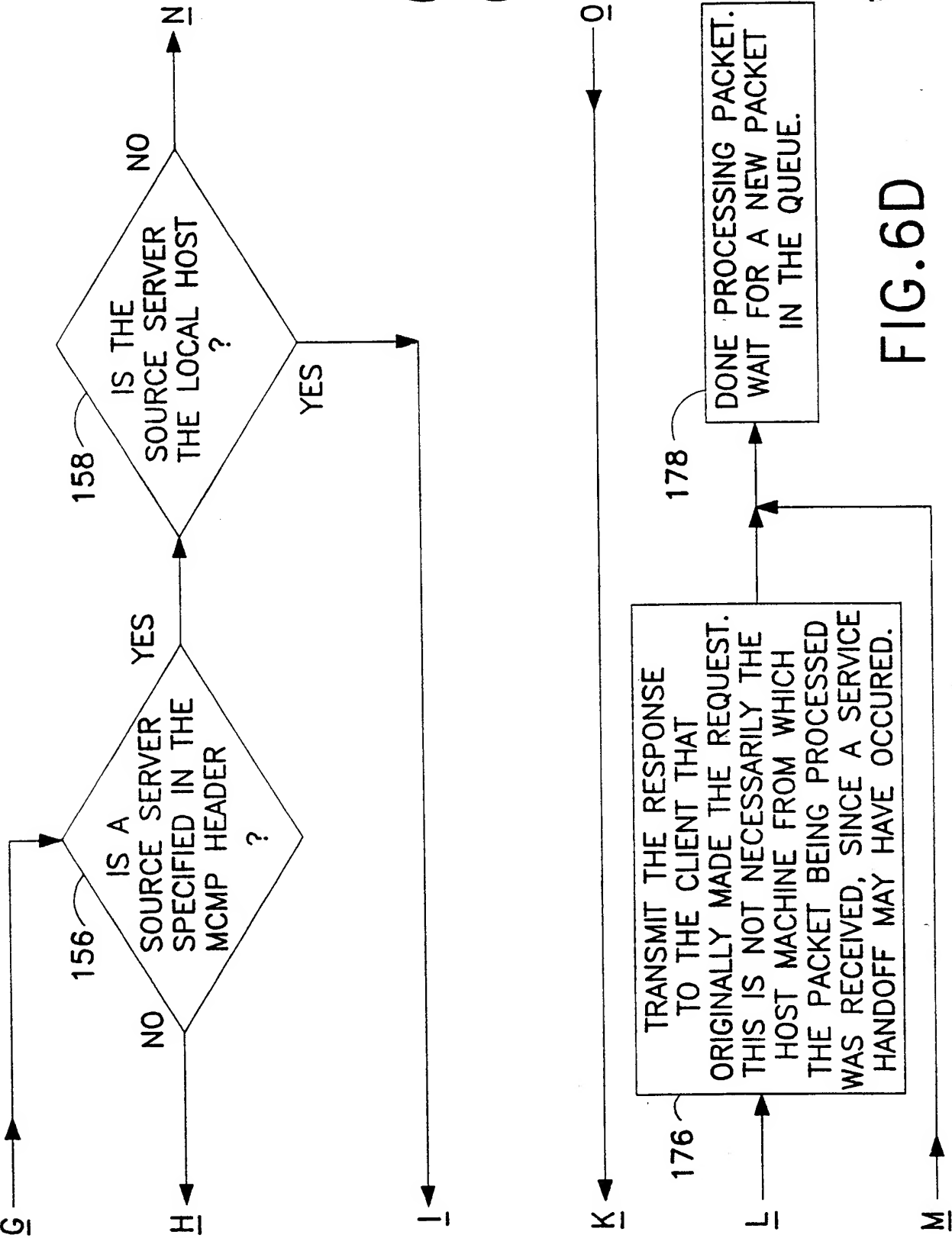
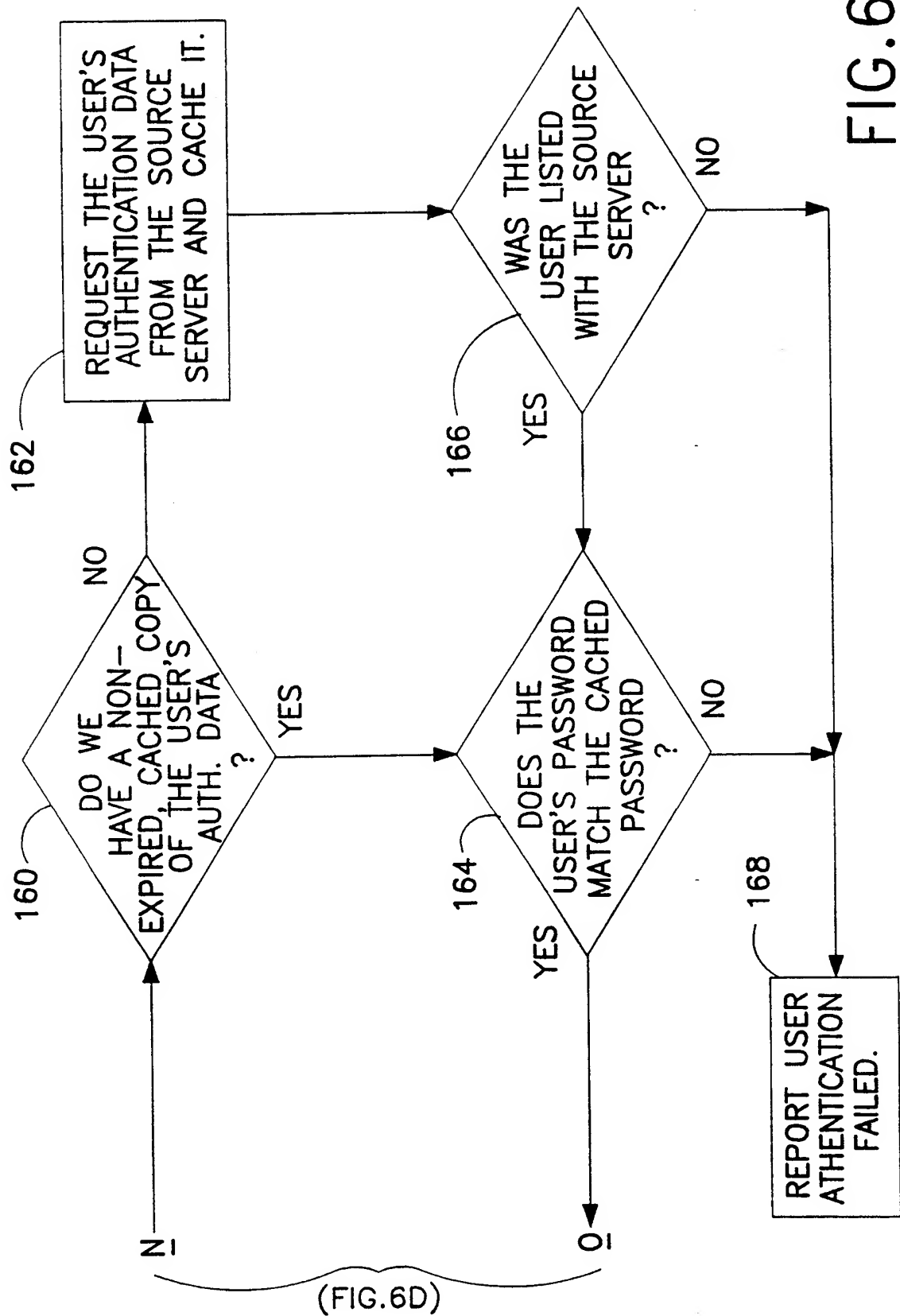


FIG.6D

(FIG.6C)



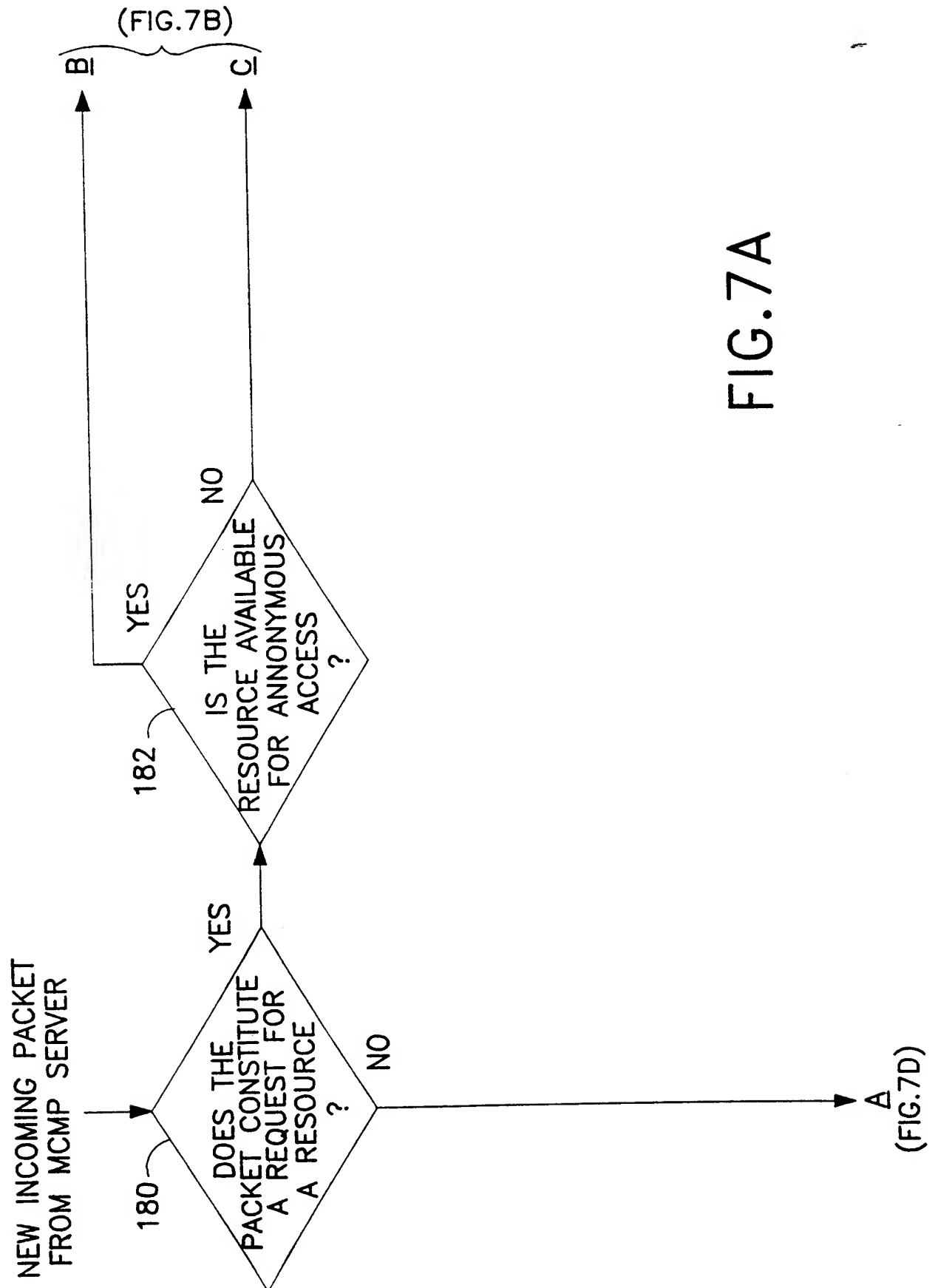
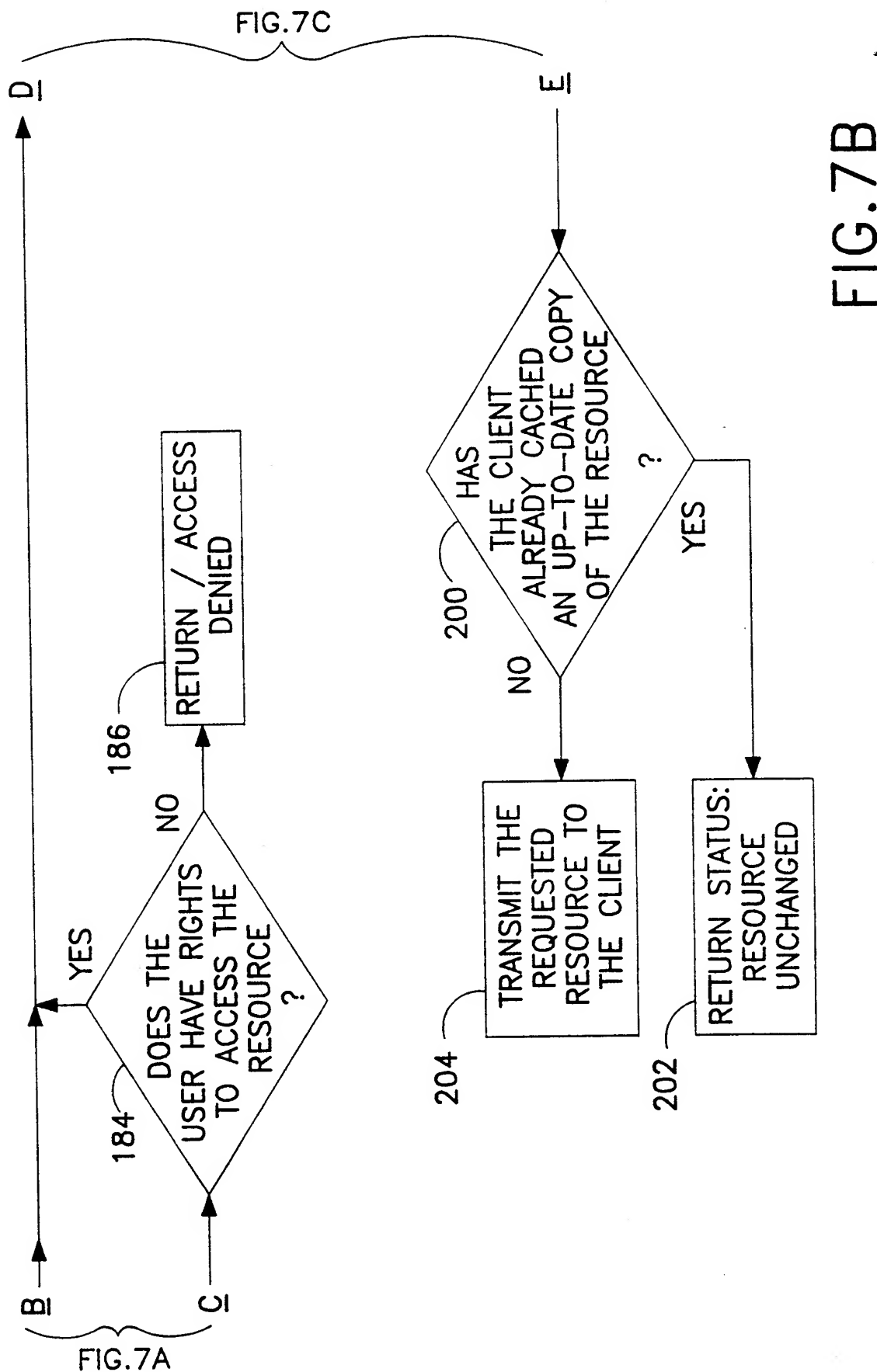


FIG. 7A





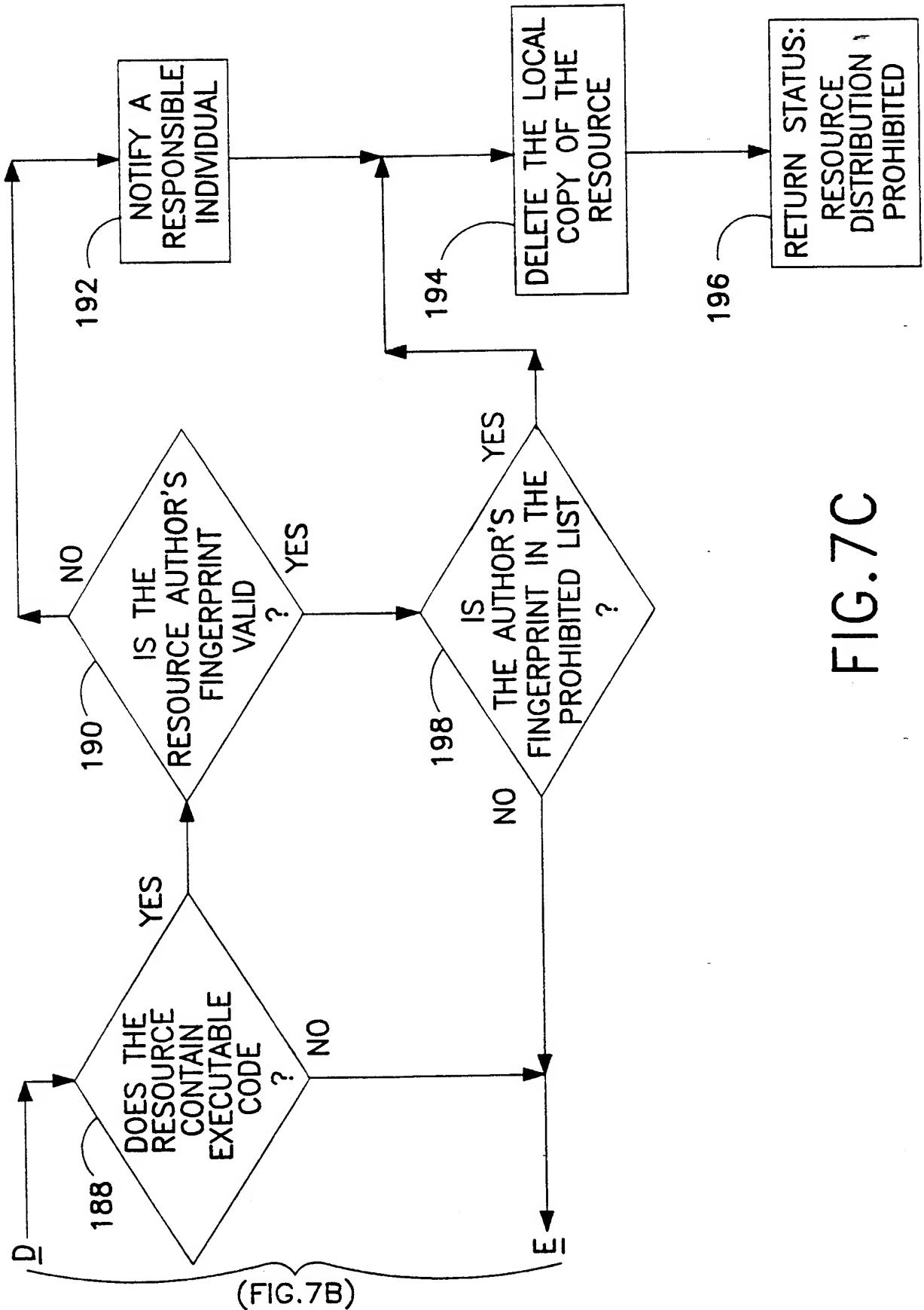
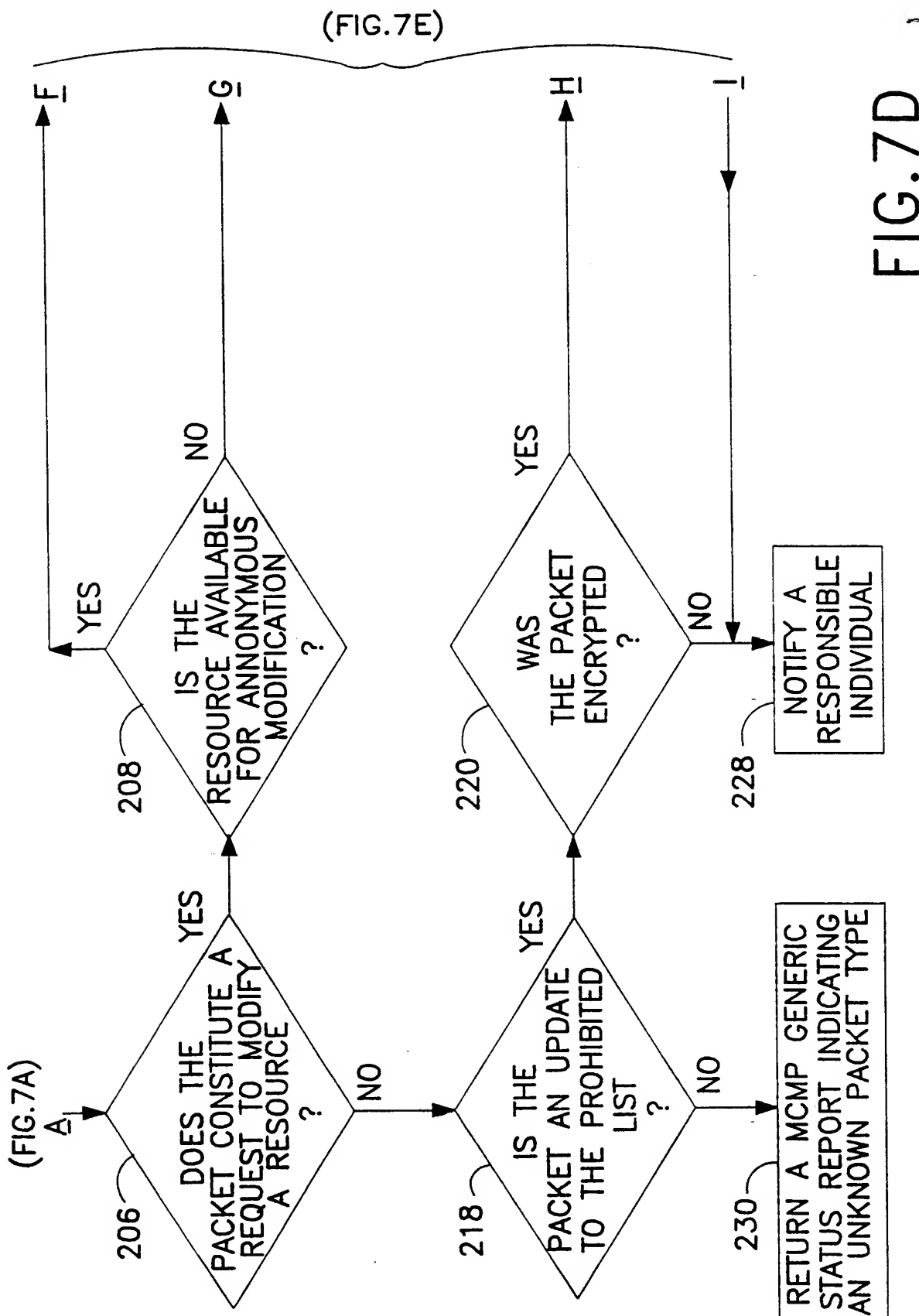
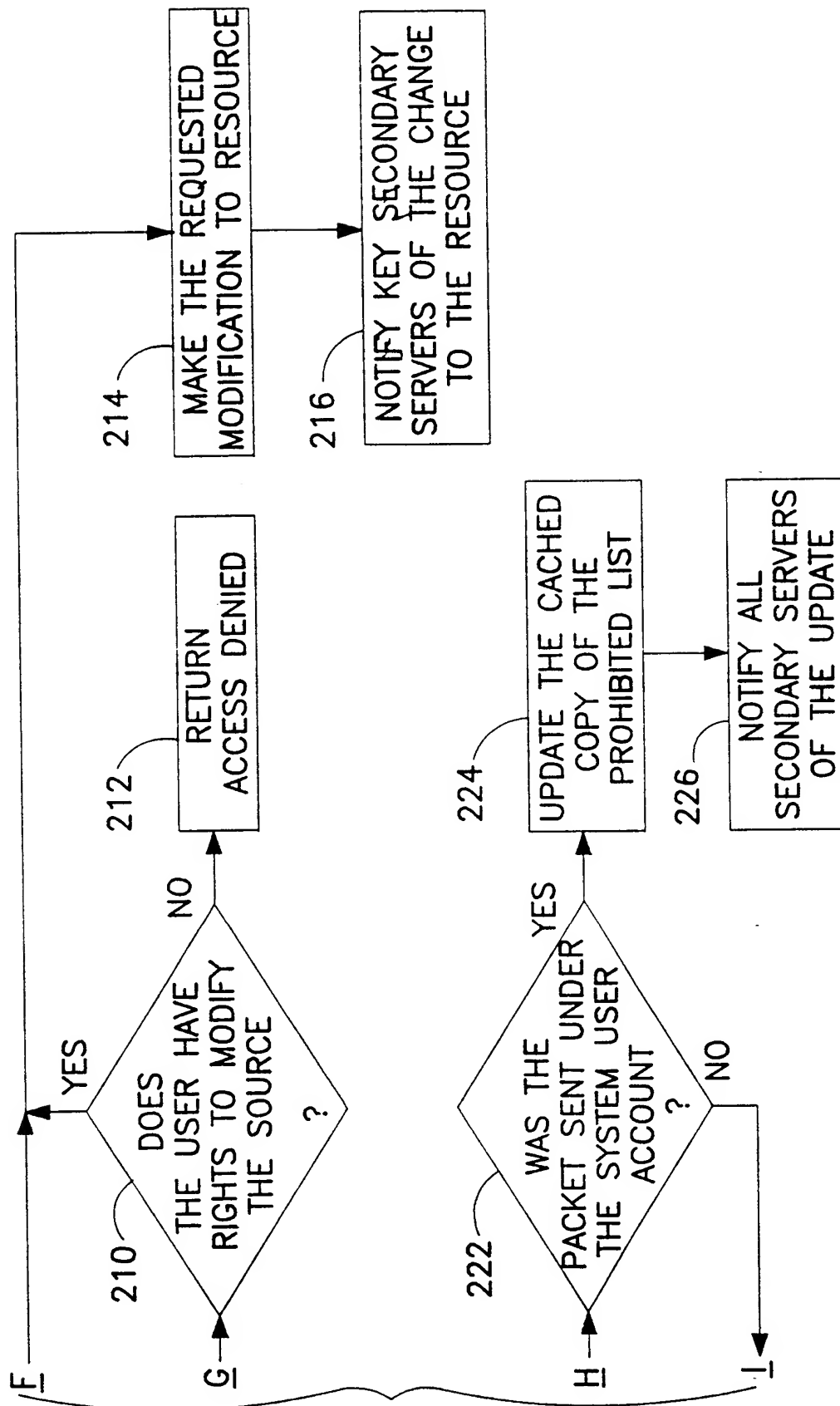


FIG. 7C





(FIG. 7D)

SUBSTITUTE SHEET (RULE 26)

FIG. 7E

(FIG.8B)

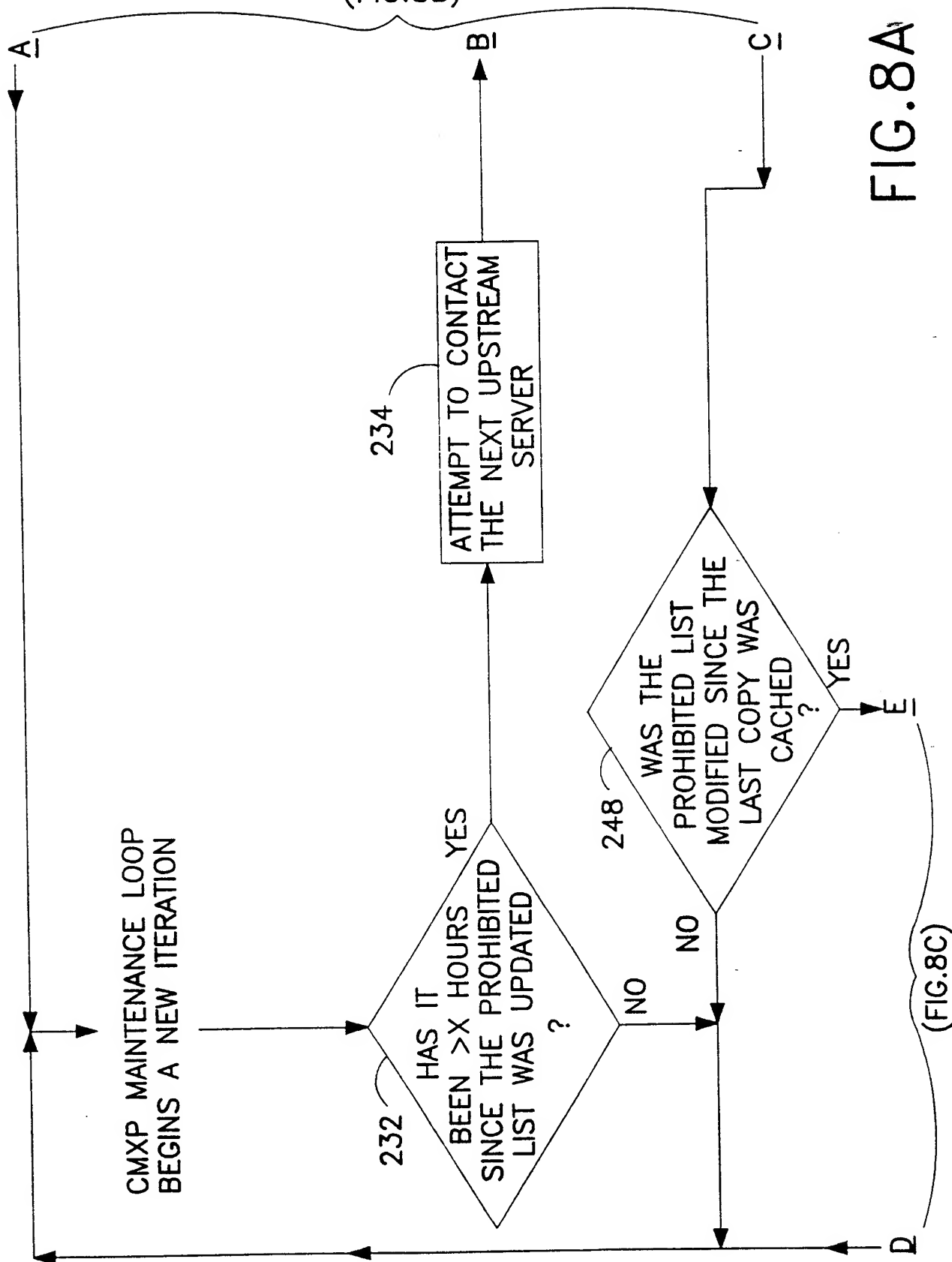


FIG.8A

(FIG.8C)

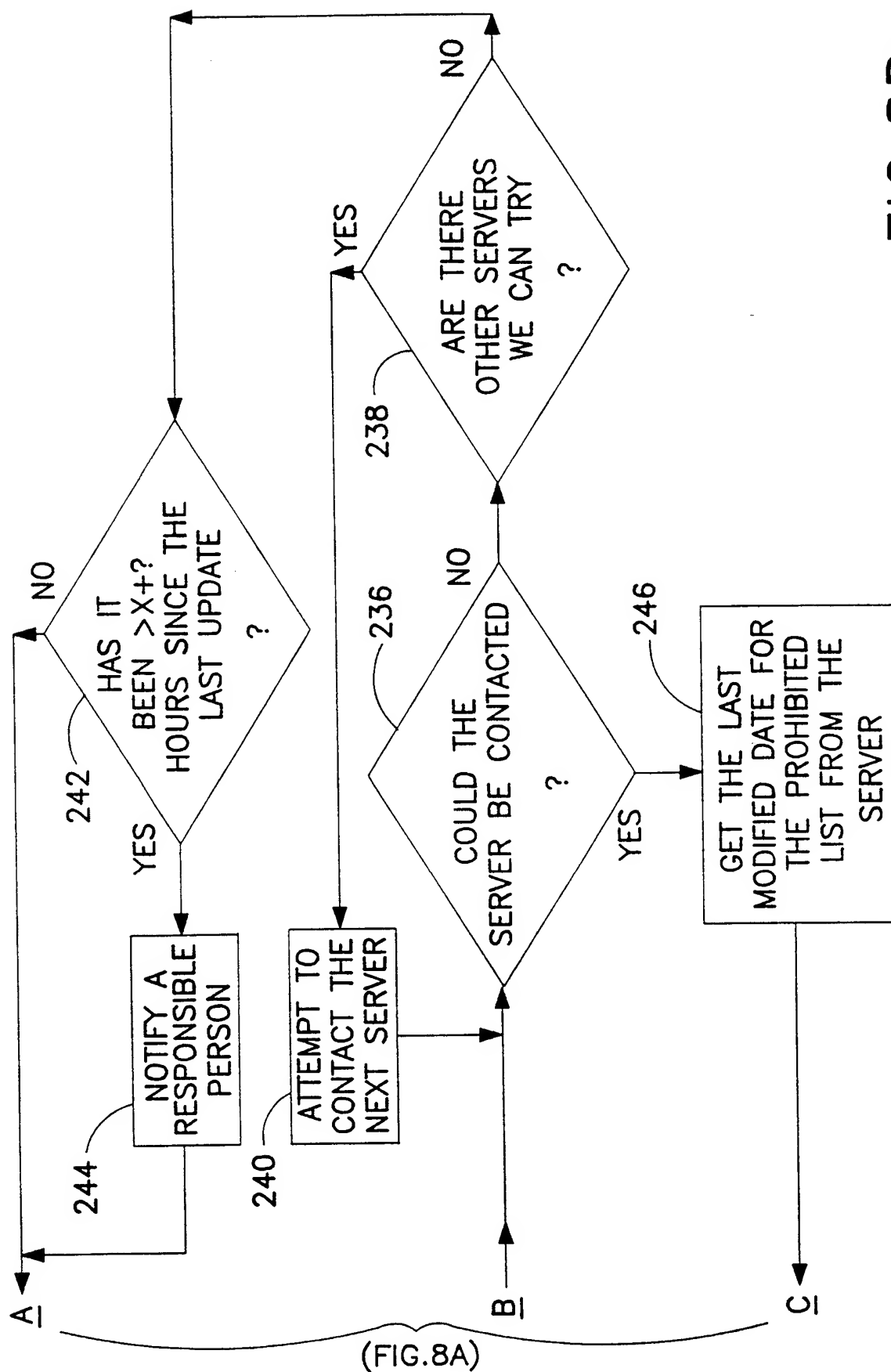


FIG. 8B

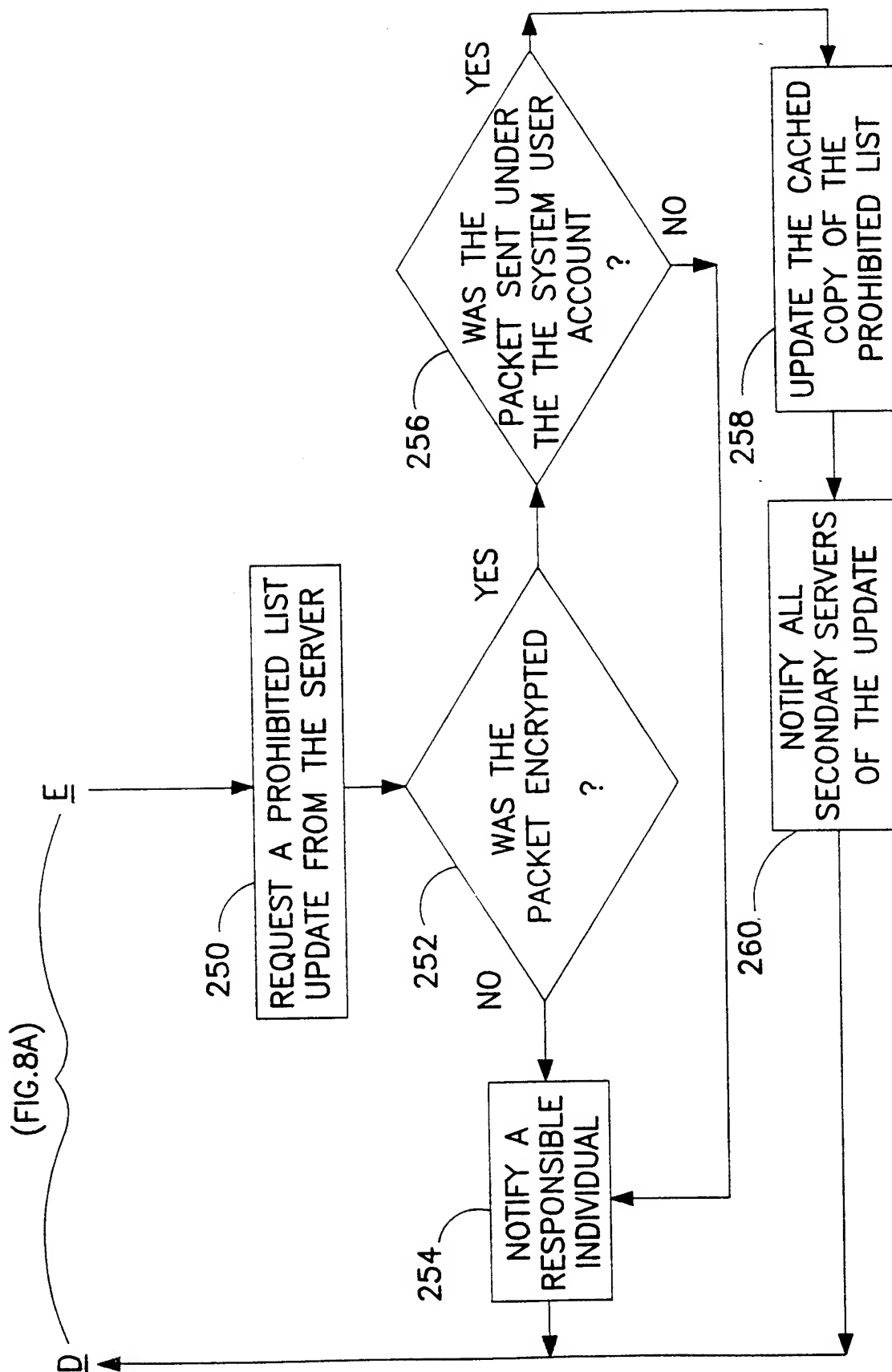


FIG. 8C

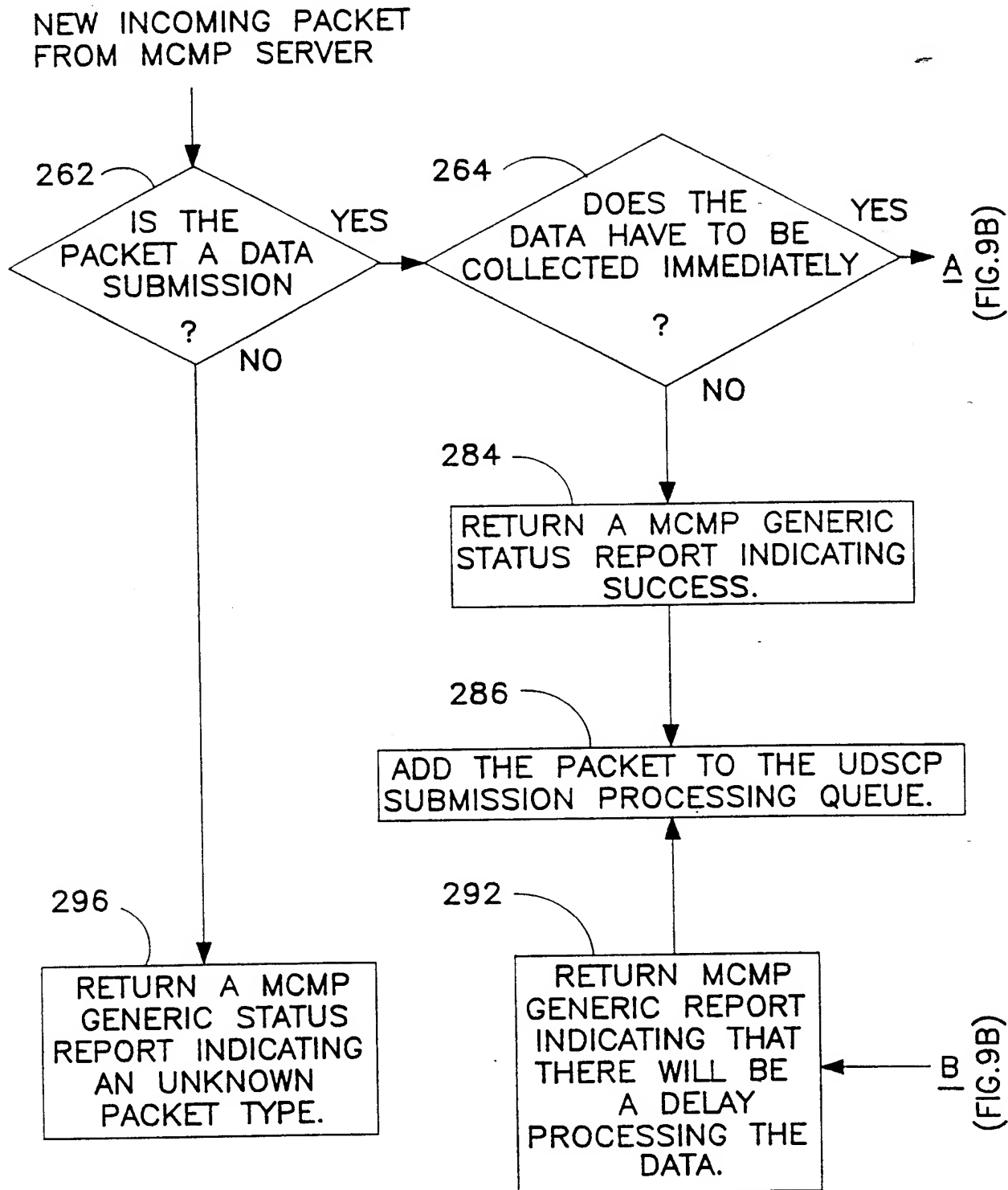
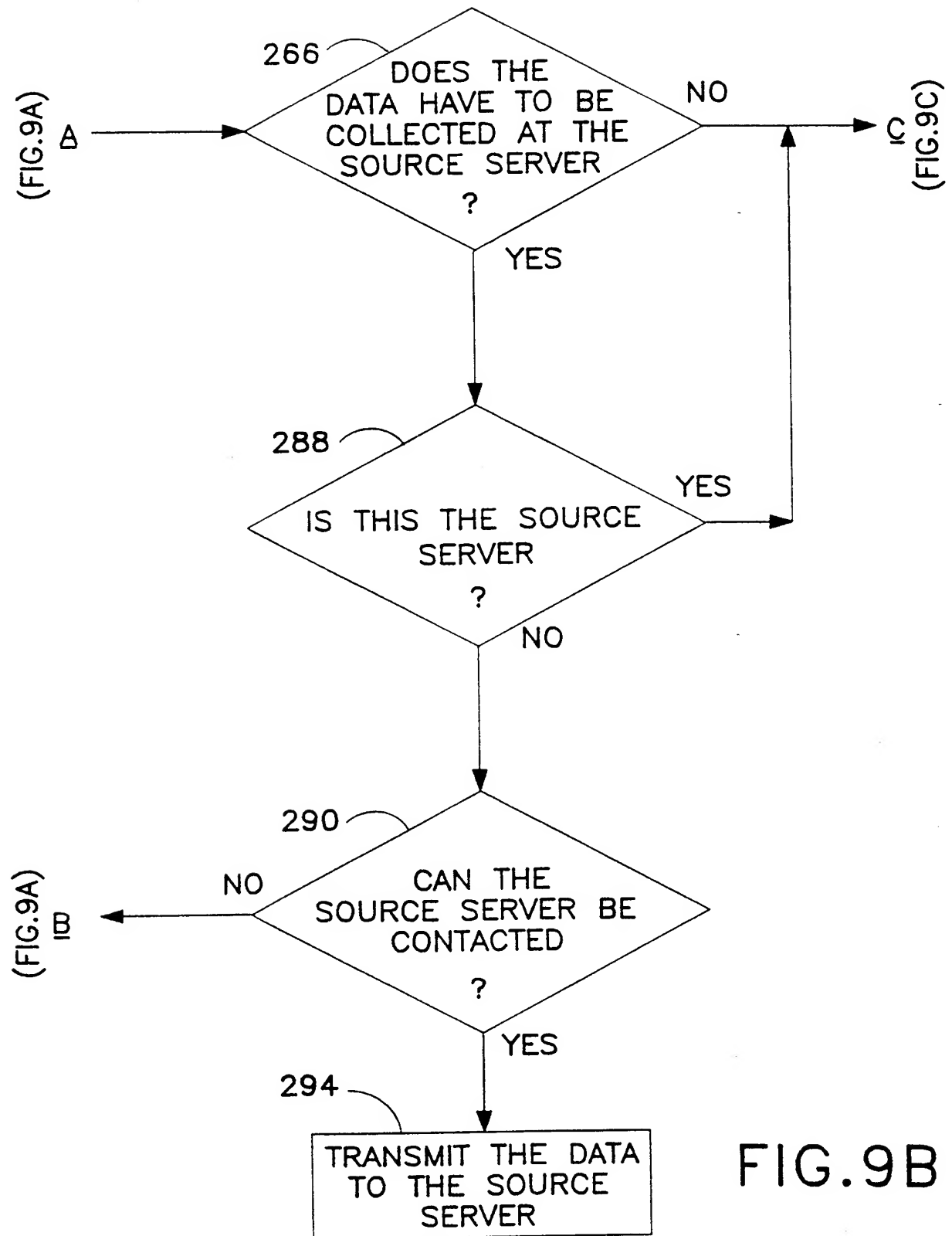


FIG. 9A





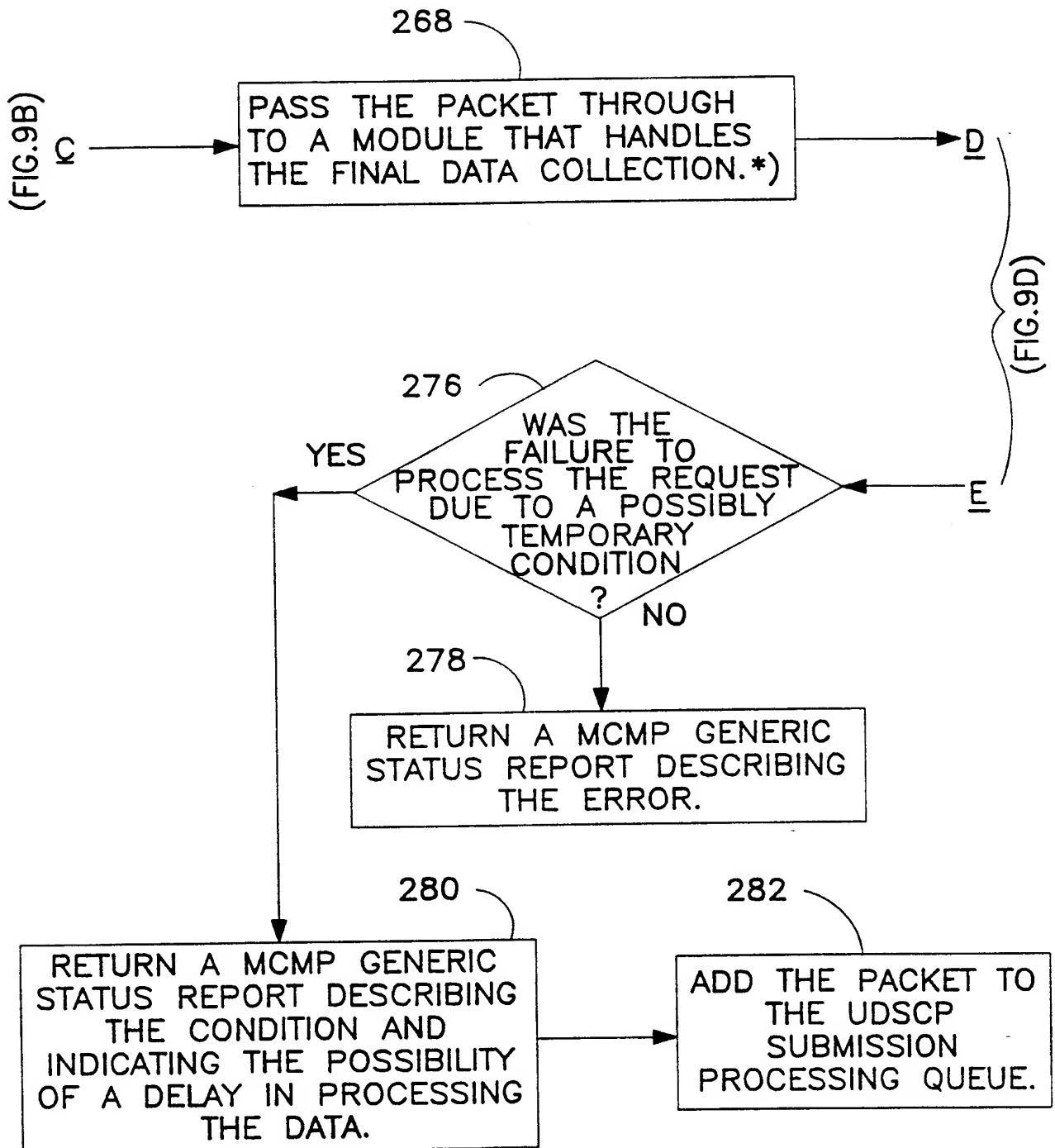
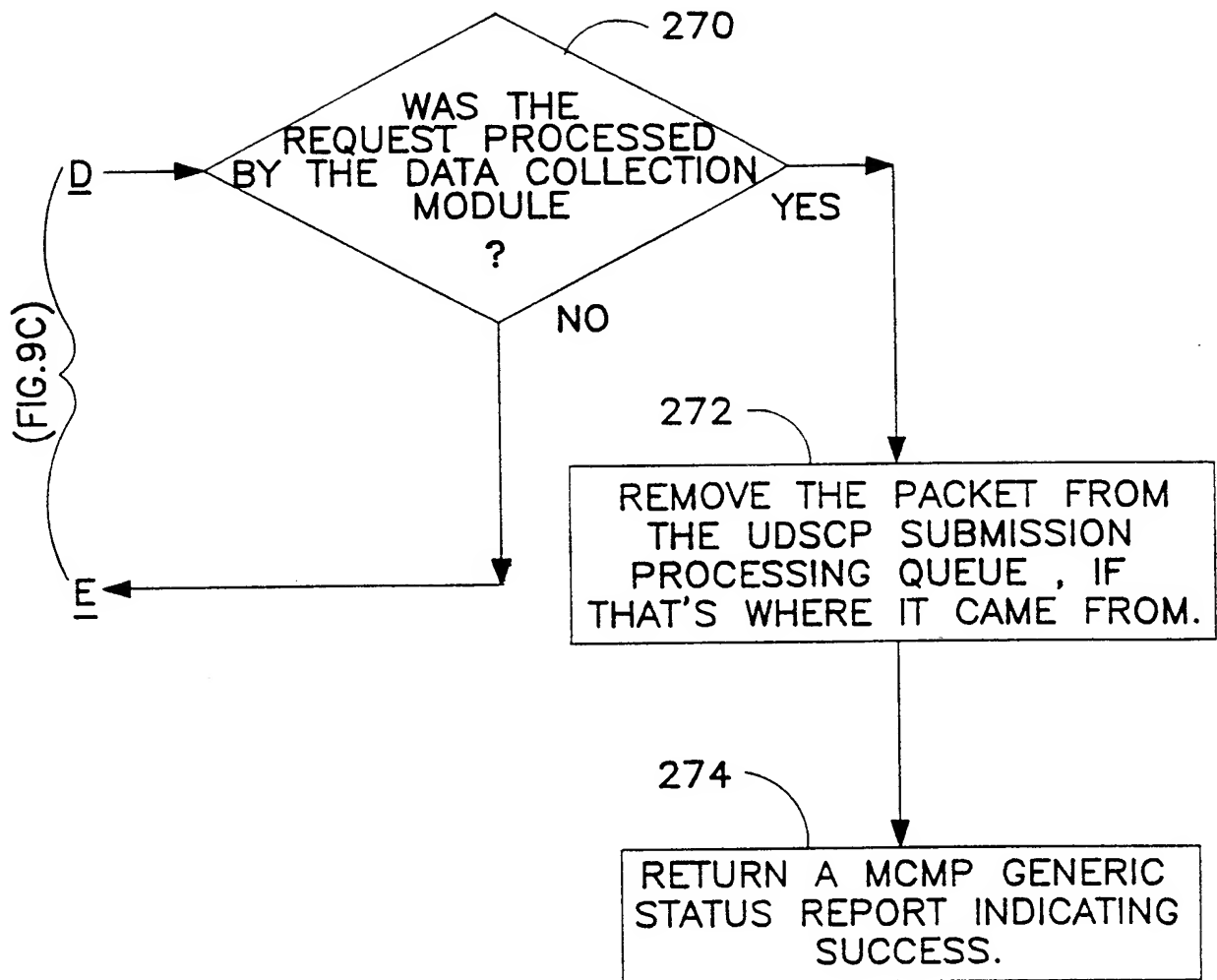


FIG.9C



\*) THIS IS THE MODULE THAT HANDLES E-MAILING THE SUBMISSION, RECORDING IT IN A DATABASE, WRITING IT TO A FILE, OR PERFORMING ANY OTHER NECESSARY SERVER-SIDE TASK WITH THE DATA..

FIG.9D

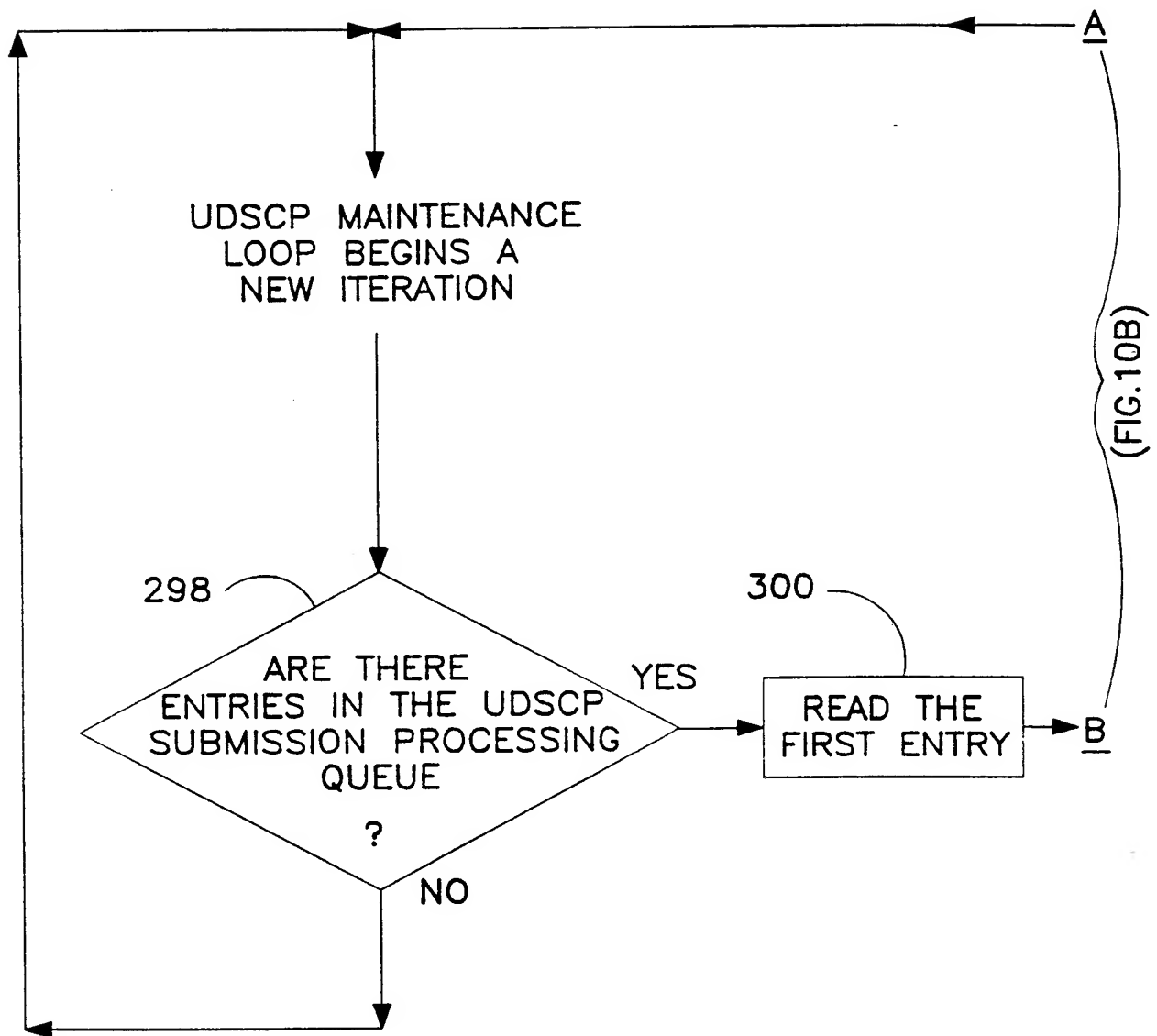


FIG. 10A

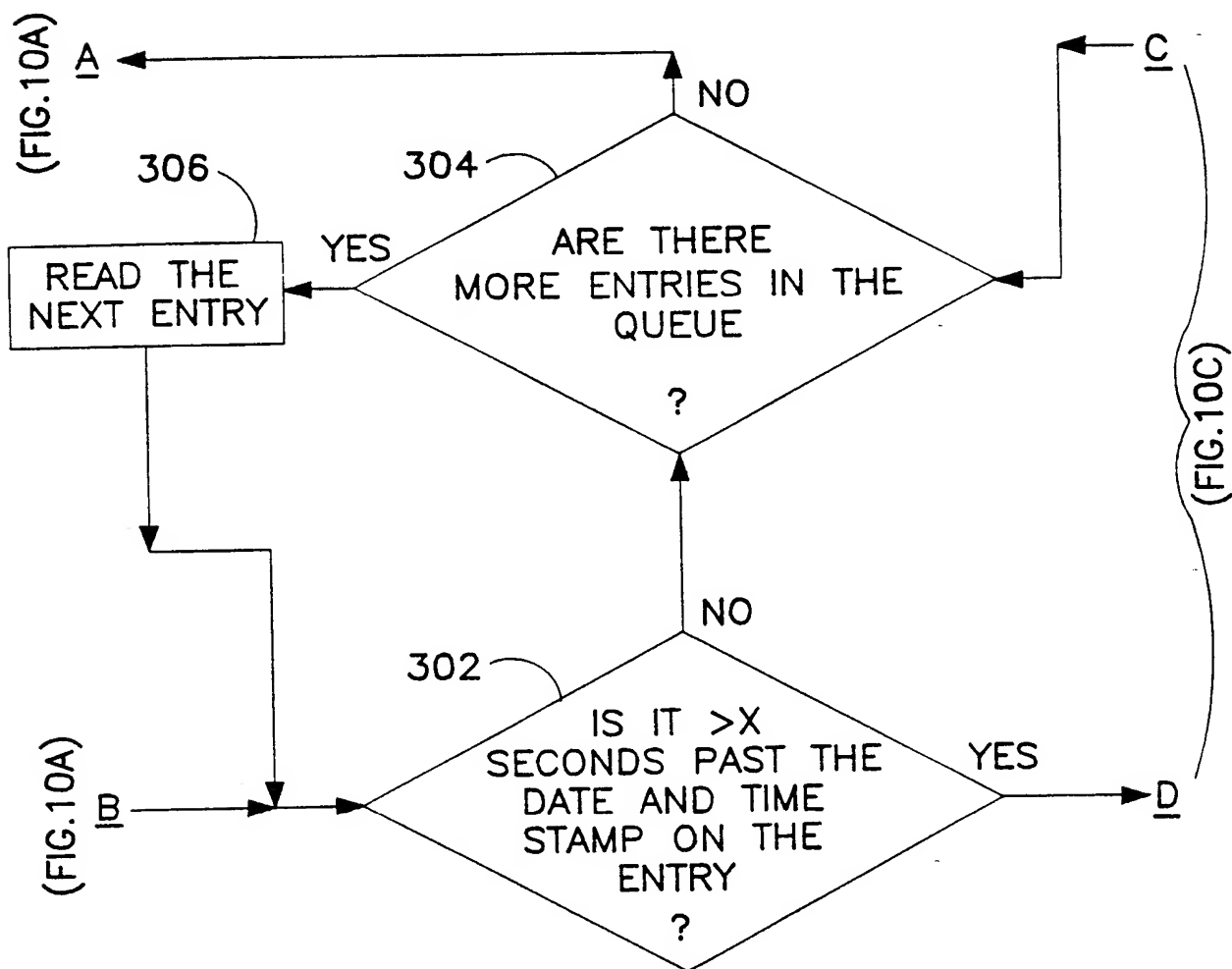
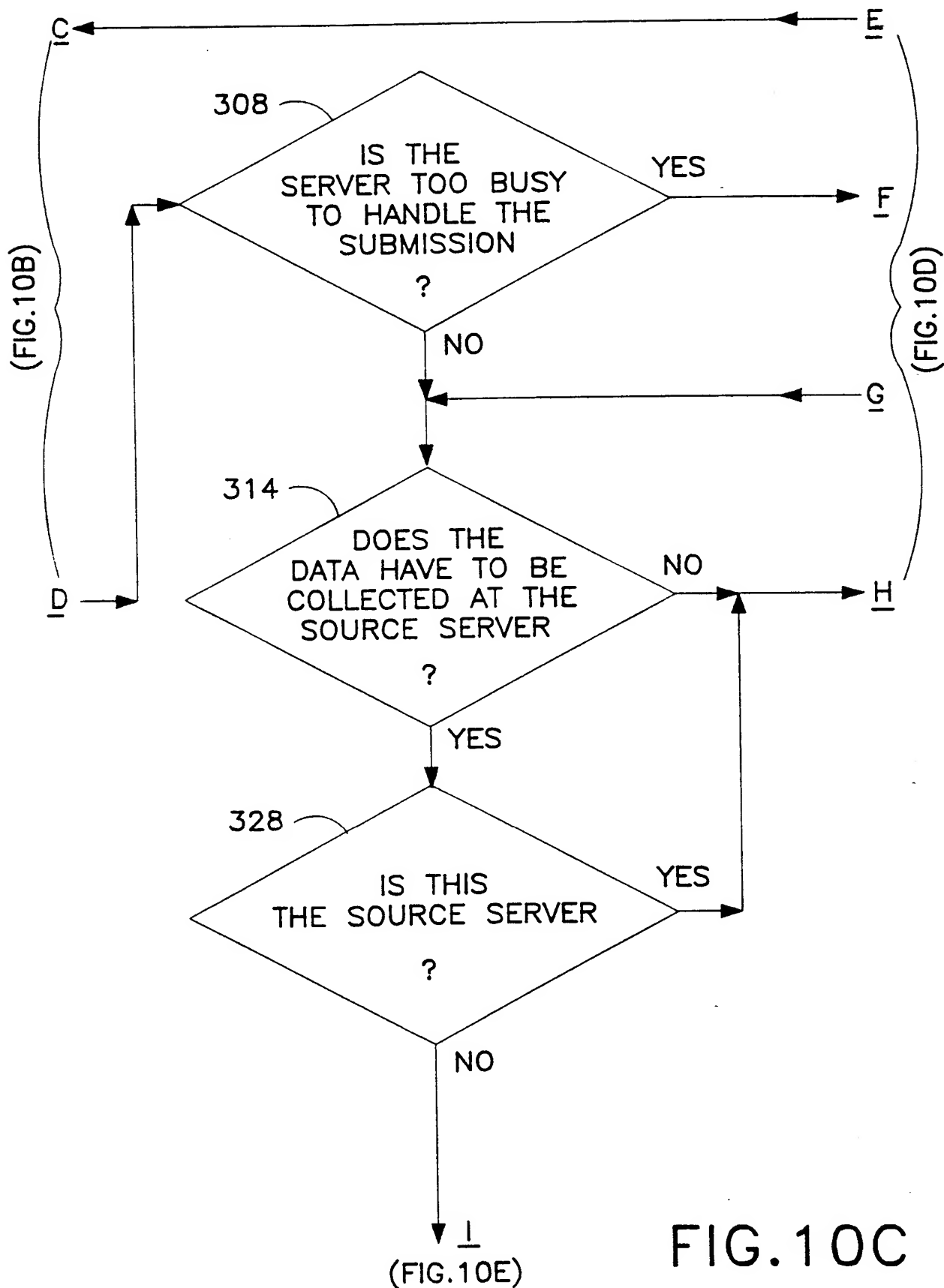
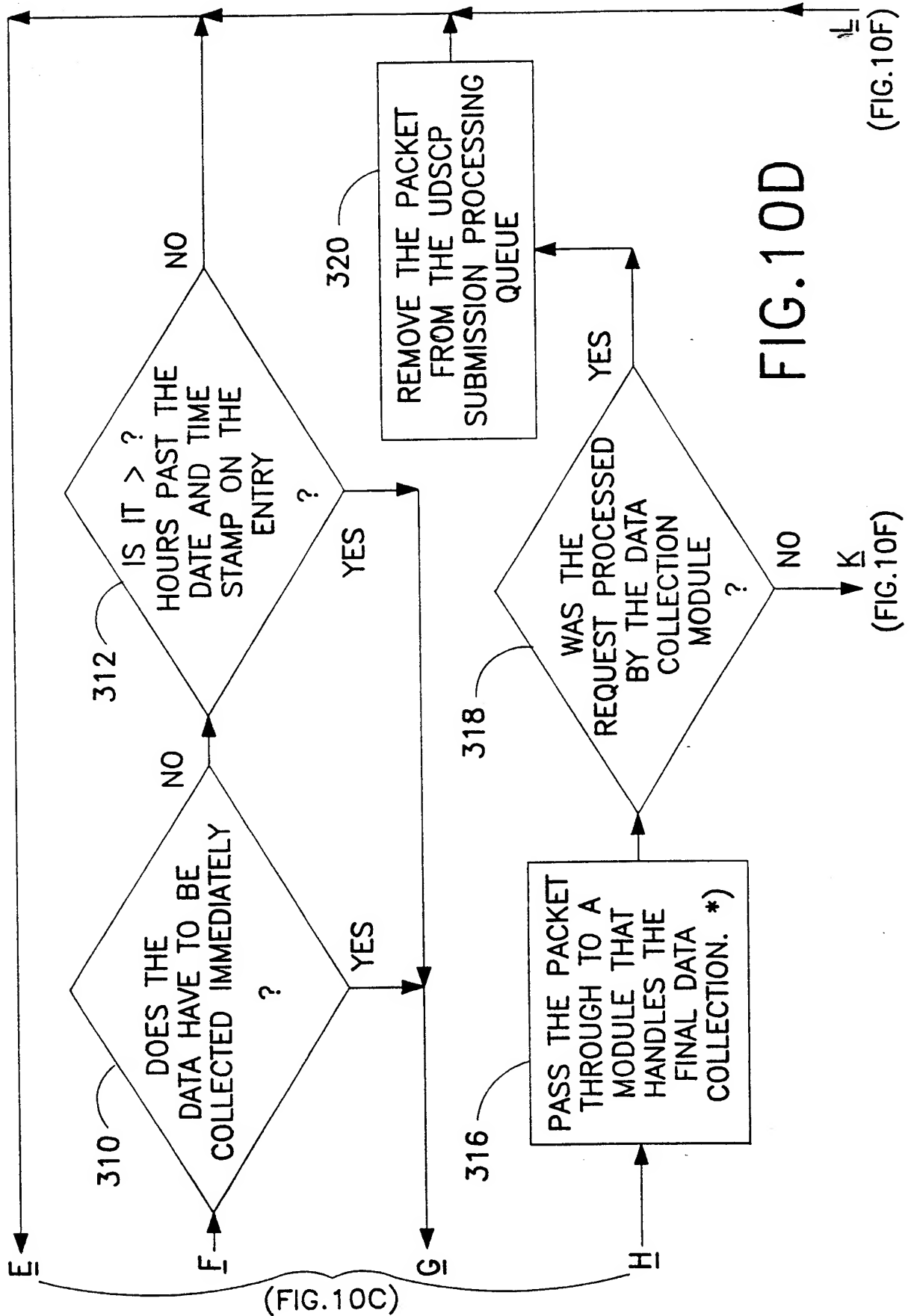


FIG.10B





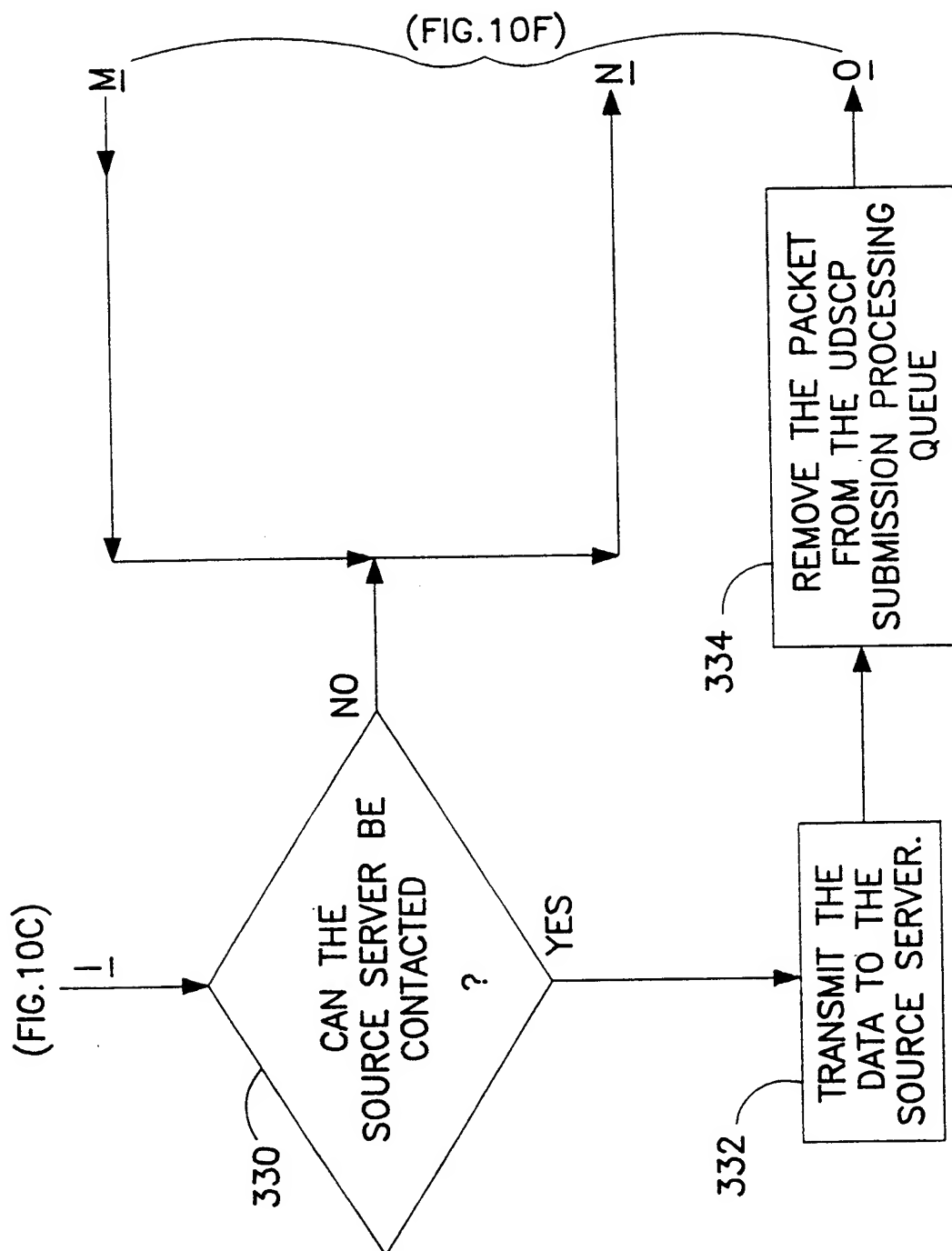


FIG. 10E

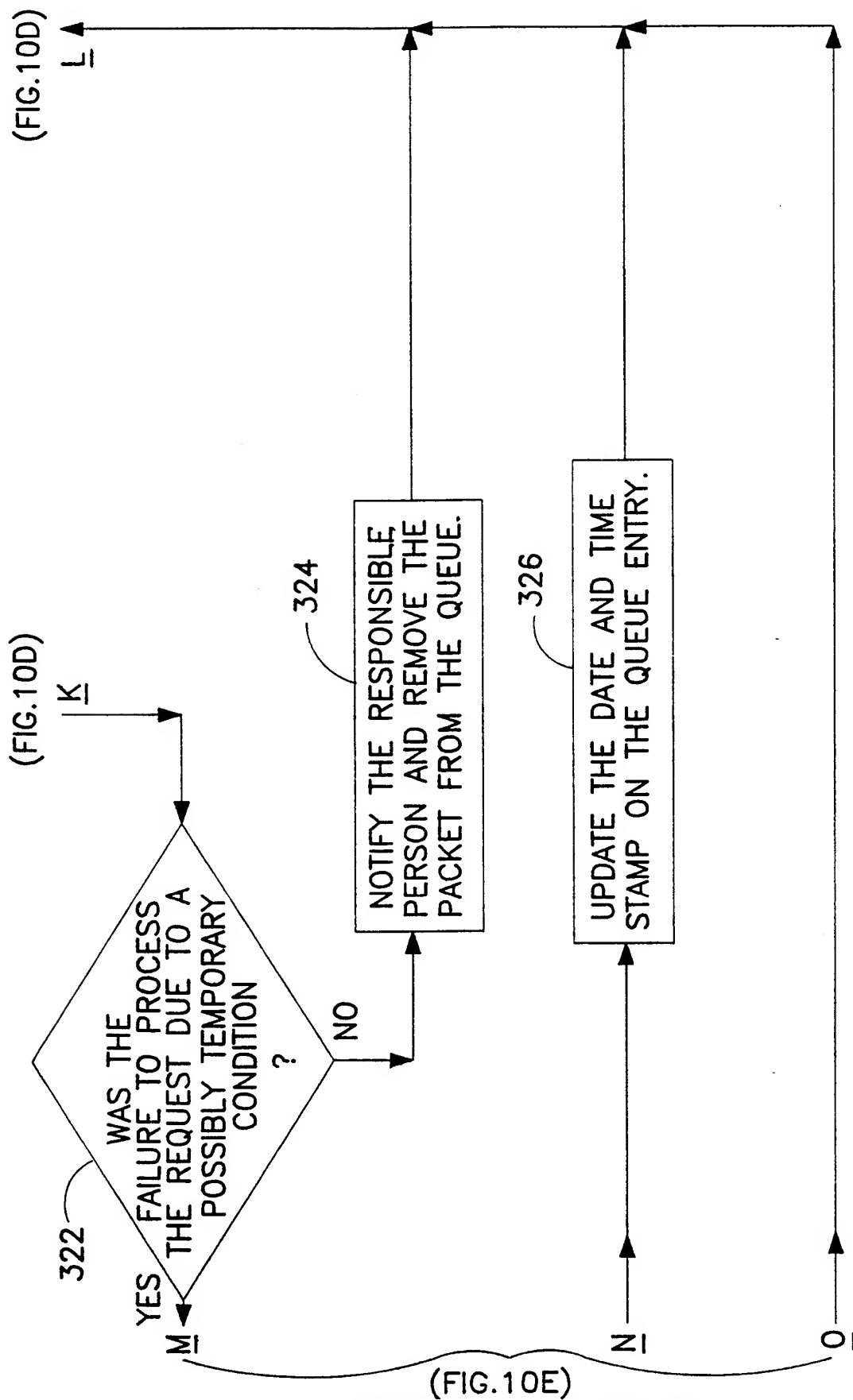


FIG. 10F

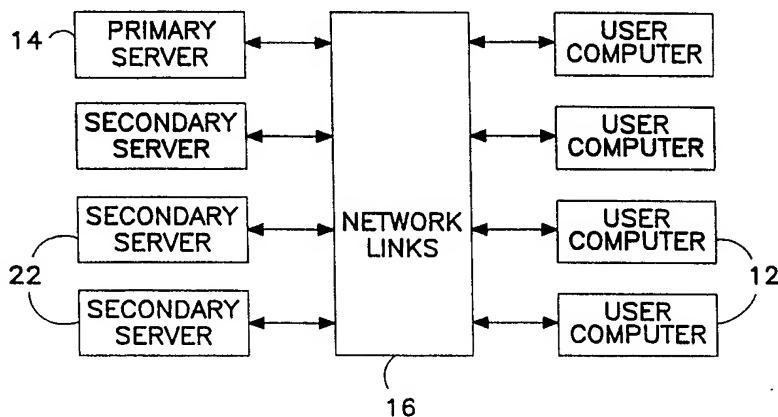




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>(51) International Patent Classification <sup>6</sup> :</b><br><b>G06F 13/00</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>A3</b> | <b>(11) International Publication Number:</b> <b>WO 99/07007</b><br><b>(43) International Publication Date:</b> 11 February 1999 (11.02.99)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>(21) International Application Number:</b> PCT/US98/15627<br><b>(22) International Filing Date:</b> 28 July 1998 (28.07.98)<br><b>(30) Priority Data:</b><br>08/902,591 29 July 1997 (29.07.97) US<br><b>(71) Applicant:</b> CATHARON PRODUCTIONS, INC. [US/US];<br>2119 Route 66, Ghent, NY 12075-2408 (US).<br><b>(72) Inventors:</b> FEINBERG, Michael, A.; 2119 Route 66, Ghent,<br>NY 12075-2408 (US). FEINBERG, Matthew, A.; 2119<br>Route 66, Ghent, NY 12075-2408 (US).<br><b>(74) Agent:</b> SUDOL, R., Neil; Coleman Sudol, LLP, 13th floor, 270<br>Madison Avenue, New York, NY 10016 (US). |           | <b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR,<br>BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE,<br>GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ,<br>LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW,<br>MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ,<br>TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent<br>(GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent<br>(AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent<br>(AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT,<br>LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI,<br>CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).<br><br><b>Published</b><br><i>With international search report.</i><br><i>Before the expiration of the time limit for amending the claims</i><br><i>and to be republished in the event of the receipt of amendments.</i><br><br><b>(88) Date of publication of the international search report:</b><br>14 May 1999 (14.05.99) |

**(54) Title:** COMPUTERIZED SYSTEM AND ASSOCIATED METHOD FOR OPTIMALLY CONTROLLING STORAGE AND TRANSFER OF COMPUTER PROGRAMS ON A COMPUTER NETWORK

**(57) Abstract**

A computerized system and method for optimally controlling storage and transfer of computer programs between computers on a network to facilitate interactive program usage. In accordance with the method, an application program is stored in a nonvolatile memory (20) of a first computer (14) as a plurality of individual and independent machine-executable code modules. In response to a request from a second computer (12) transmitted over a network link, the first computer (14) retrieves a selected one of the machine-executable code modules and only that selected code module from the memory and transmits the selected code module over the network link to the second computer (12).

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US98/15627

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G06F 13/00

US CL :395/200.3,200.33,200.46,200.62,200.48,200.49,675

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 395/200.3,200.33,200.46,200.62,200.48,200.49,675

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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                          | Relevant to claim No.                           |
|-----------|-----------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|
| Y         | US 5,475,819 A (MILLER et al.) 12 December 1995, col. 2, lines 5-43, col. 3, lines 5-60, col. 5 line 16 to col. 7, line 48. | 1-2,4-8,<br>10-17,<br>21-27,<br>29-32,<br>34-36 |
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| A                                                     | US 5,819,020 A (BEELER, Jr.) 06 October 1998, see the whole reference.             | 1-36                  |
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